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ANNUAL REPORT

OF THE

South Carolina Experiment Station

AT

CLEMSON AGRICULTURAL COLLEGE,

FOR THE YEAR ENDING

June 30, 1901.

1902
ALLAN NICHOLSON PRESS,
UNION, S. C.

1

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R. N. Brackett, Ph. D.	Assistant Chemist
G. E. Nesom, B. Sc., D. V. M.	Veterinarian
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P. H. Rolfs	Botanist and Bacteriologist
C. M. Conner, B. S.	Assistant Agriculturist
A. P. Anderson, Ph. D.	Entomologist
*B. F. Robertson, B. S.	Assistant Chemist
J. S. Pickett	Foreman

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*Engaged in Fertilizer Analyses.

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LETTER OF TRANSMITTAL.

Hon. M. B. McSweeney, Governor of South Carolina:

Dear Sir: I have the honor to submit herewith the annual report of the South Carolina Experiment Station for the year ending June 30, 1901.

Respectfully submitted,

HENRY S. HARTZOG,

Director.

Clemson College, S. C., January 20, 1902.

634012

Report of Agriculturist.

To Dr. Henry S. Hartzog, Director:

Dear Sir: The following report of work, completed and in progress, in the Agricultural Division for the fiscal year ending June 30th, 1901, is respectfully submitted.

Experiments Completed.

Wheat Following Nitrogen Collectors and Nitrogen Consumers: After growing corn, sorghum, teosinte, peas and velvet beans on the same plots two years, wheat was sown on all of the plots. Results showed that the legumes supplied all the nitrogen needed by the wheat.

Varieties of Wheat: Comparison of a large number of the most popular varieties resulted generally in favor of those which are acclimated in this latitude.

Fertilizers for Sweet Potatoes: Comparison of potash derived from different sources in combination with other standard ingredients have not sustained the common theories on this subject.

Fertilizers for Cotton: Experiments have been conducted for a series of years with results indicating that phosphoric acid is the principal element needed on this soil.

Varieties of Sorghum have been compared for two years testing the percentage of saccharine matter as determined by chemical examination and the actual yield of syrup from each variety.

Varieties of Corn: Standard varieties from the Middle States and those long grown in this latitude have been compared.

Hops: An effort to grow this crop proved unsatisfactory on account of the destructive attack of a fungous disease.

Forage Plants: A comparison of a large number of forage crops suggests teosinte as the most promising for green soiling and fodder production. Results of these experiments will be published in bulletin form.

Experiments in Progress.

Varieties of Cotton: Standard varieties have been com-

pared during three years and these were compared last summer with some cross-bred and hybrids which have resulted from *Artificial Plant Breeding*. This work, commenced in 1898, is still in progress. Some important developments have resulted which encourage its continuance. Hybrids are usually very promising the first year but confusing in the second and third reproductions.

Corn Culture has been under experiment during two seasons peculiar in meteorological conditions. This will be continued.

Nitrogen Experiments with corn require further investigation for reasons stated in regard to its culture.

Grass Garden: A large number of varieties of grasses and legumes, sown singly and in various combinations, constitutes the grass garden. These, according to their habits of growth, are cultivated for lawns, pasturage or hay. Some native species are thus far very promising.

Hog Crops: These have been subjects of investigation for several years under unsatisfactory conditions. It is proposed to continue experiments with varieties of swine with the growing of crops which can be harvested by the hogs, using movable fences for this purpose. This will be continued and developed as rapidly as the necessary means for conducting it are supplied.

Evaporating the Sweet Potato: To avoid the annual loss in this important crop an investigation of means of preparing the potato as well for home use as for transportation to distant markets so as to avoid the rot and put them into condition to be kept indefinitely, was commenced three years ago in evaporating the potato. Results already obtained give promise of rendering the sweet potato an important article of domestic and foreign commerce.

This division is co-operating with the U. S. Department of Agriculture by testing varieties of plants, which promise useful additions to those already grown.

The usual Institute work was performed during the College vacation.

Poultry Division.

Mr. O. M. Watson has been striving faithfully, under

many difficulties, to organize the division for experiment work but having taken charge late in the spring of 1900, no experiments have been brought to a conclusion. He issued an instructive popular bulletin on "Capons and Caponizing," and proved a successful and efficient Institute worker. Experiments in progress are:

(a) Comparison of different breeds in egg production.

(b) Comparison of fertility of the eggs of different breeds subjected to same treatment.

(c) Comparison of different breeds for production of early broilers.

(d) Comparison of grades from the thoroughbreds of different breeds as producers of broilers.

Respectfully submitted,

J. S. Newman,
Agriculturist.

Report of Assistant Agriculturalist.

Clemson College, S. C., Jan. 20, 1902.

Dr. H. S. Hartzog, Director,

Dear Sir: I have the honor to submit herewith the report, of the Division of Live Stock and Dairy, for the fiscal year ending June 30, 1901.

The work of this division has been carried out according to the plans given in the last report, so far as possible.

The work, of collecting data relating to the comparative value of the different breeds of cattle for dairy purposes, was continued up to the first of March, when the work was stopped and the results tabulated. These data will be published, together with such other information, as will be of interest to the stock breeders.

The experiment, to test the relative feeding value of cotton seed hulls and corn stover, has been completed so far as the material on hand would permit. This bulletin is now in the hands of the printer.

During the summer several weeks were spent attending

Farmers Institutes at which talks were given on stock raising and dairying.

Respectfully Submitted,

C. M. Conner,
Assistant Agriculturist

Annual Report State Chemist.

Clemson College, S. C., July 15, 1901.

President H. S. Hartzog, LL. D., Director of the South Carolina Experiment Station.

Sir: I respectfully submit the following report of the Chemical Department of the Station for the year ending June 30th, 1901:

I.

The following work has been completed and published: *The Rice Plant and Its Products*, by Mr. C. C. McDonnell, Bulletin 59.

The Sweet Potato, by Mr. F. S. Shiver, Bulletin 63. In this Bulletin is included the work of Mr. McDonnell referred to in my last annual report. This Bulletin is intended to supplement Bulletin 28 of this Station on the sweet potato as a starch producer, and has reference to the changes in chemical composition which the sweet potato undergoes during storage, the relative value of different methods of storing, and the effect produced on the starch content of the potato by fertilizing with different potash compounds.

Mr. Shiver has in progress an investigation of the *Tea Industry in South Carolina*, and has nearly finished writing up the results of his work on the Sea Island Cotton Seed.

With regard to the *rotation experiment* begun in conjunction with the Agricultural Department of the Station in 1896, and completed so far as the field work was concerned in 1899, I would say that notwithstanding the untoward circumstances which have occurred and the unfortunate suspension of the analytical work due to the protracted illness of Mr. Shiver, it is still hoped that something of interest may be derived from

the results of the numerous analyses of soils and crops which have been made in this connection. Too much careful analytical work has been done to abandon the investigation entirely, and Mr. Shiver reports that he hopes to have the results he has obtained in shape for publication by the first of next year.

The experiments with acid phosphates containing small quantities of free sulphuric acid are being continued, the field work being conducted by the Agricultural Department of the Station.

The following *miscellaneous and routine analyses* have been made during the year.

12 samples of sorghum juice. 1 sample of artichokes, one of teosinte, 1 of chufas and 1 of "evaporated" sweet potatoes for the Agricultural Department of the Station by Mr. Shiver, and one sample of rice meal from Waverly Mills, S. C., by Messrs. Shiver, McDonnell and Robertson.

II.

State Analytical Work.

Following is an account of the work on commercial fertilizers, drinking water, minerals, ores, &c., done at the Station under the direction of the Board of Fertilizer Control.

Summary of the Work.

	Year ending June 30, 1900.	Year ending June 30, 1901.
Official samples of fertilizers	38	335
Farmers' samples of fertilizers	19	41
Waters	89	58
Marls	2	4
Ores and Minerals	17	23
Clays	6	8
Miscellaneous	8	8
	471	477

Official Samples of Fertilizers

The number of samples analyzed this year is 335. The analyses are given in full in Bulletins 60 and 64 of this Station.

Classification.

	1900	1901
Complete fertilizers	124	139
Acid phosphates	73	56
Acid phosphates with potash	63	55
Kainits	8	12
Cotton seed meals	52	60
Nitrate of soda	3	3
Sulphate of potash	0	2
Muriate of potash	4	2
Manure salt	0	1
Nitrate of soda with potash salts	1	1
Dried blood	1	0
Fish scrap	1	0
Tankage	0	2
Miscellaneous	0	2
	330	335

Deficient Samples.

Of the 335 samples analyzed, 12 *were deficient under the law*, that is their commercial value based upon analysis fell 3 per cent. or more below the commercial value based upon guarantee.

In addition to these, there were 57 samples which fell below guarantee in or more constituents as follows:

In available phosphoric acid and potash	2
In potash and ammonia	5
In available phosphoric acid	7
In ammonia	19
In potash	24

The extent to which these fell below guarantee is shown in the following table:

	Below Guarantee—Per Cent.				
	0 to .1	.1 to .25	.25 to .50	.50 to 1.	1.and over
In ammonia	5	6	9	4	0
In avail. phos. acid	1	2	4	1	1
In potash	5	9	11	5	1
Total	11	17	24	10	2

In these samples the deficiences were made up in money value by an excess of other constituents and hence these fertilizers do not fall under the ban of the law. It is, however, not simply a matter of dollars and cents, with the farmer, but a question of pounds of ammonia, phosphoric acid and potash. It is obviously not right when a farmer pays for 60 pounds of ammonia that he should be furnished with only 40 pounds and have the money deficit made up to him in phosphoric acid and potash.

Averages of Analyses.

	1900 Per Cent.		1901 Per Cent.	
	Found	Guaran.	Found	Guaran.
ACID PHOSPHATES.				
Soluble phosphoric acid	10.00	.....	10.18	.....
Reverted phosphoric acid	3.58	.....	3.82	.....
Available phosphoric acid	13.58	12.58	14.00	13.02
Insoluble phosphoric acid	1 24	.....	1.30	.....
Total phosphoric acid	15.00	.....	15.30	.....
ACID PHOSPHATES WITH POTASH.				
Soluble phosphoric acid	8.17	.....	6.62	.....
Reverted phosphoric acid	3.41	.....	4.87	.....
Available phosphoric acid	11.58	10.48	11.49	9.98
Insoluble phosphoric acid	1.31	.....	1.22	.....
Total phosphoric acid	12.89	.....	12.71	.....
Potash soluble in water	2.00	1.84	2.65	2.42
COMPLETE FERTILIZERS.				
Soluble phosphoric acid	6.58	.....	6.46	.....
Reverted phosphoric acid	2.92	.....	2.94	.....
Available phosphoric acid	9.50	8.19	9.40	8.09
Insoluble phosphoric acid	1.76	.....	1.60	.....
Total phosphoric acid	11.26	.....	11.00	.....
Ammonia	2.73	2.59	2.87	2.74
Potash soluble in water	2.13	1.85	2.47	2.19
COTTON SEED MEALS.				
Available phosphoric acid	2.27	1.64	2.38	1.57
Ammonia	8.73	7.46	8.55	7.54
Potash soluble in water	1.63	1.00	1.54	1.00
KAINIT.				
Potash soluable in water	12.73	12.00	12.61	12 17
MURIATE OF POTASH.				
Potash (equivalent)	50.95	51.25	48.92	49 00
SULPHATE OF POTASH.				
Potash	.....	.....	49.43	46.50
SODIUM NITRATE.				
Ammonia (equivalent)	19.01	18.00	18.96	18.00

The available phosphoric acid and potash in the cotton seed meals were guaranteed in only fourteen samples, but these ingredients were determined in all cases:

Grades.

In the following table the number of acid phosphates and complete fertilizers of each grade according to guarantee, is placed side by side with the number found by analysis to belong to that grade.

	High.		Standard		Low	
	Claimed	Found	Claimed	Found	Claimed	Found
Complete fertilizers .(139)	46	75	77	60	16	4
Acid phosphates.....(50)	44	48	12	8	.....	.....
Acid phos.with potash(55)	13	48	42	6	.....	1
Total.....(250)	103	171	131	74	16	5

These results are due to the following changes in grade ascertained by analysis:

Change.	Low to Standard	Standard to High	Low to High	High to Standard	Standard to Low	High to Low	No Change
Complete fertilizers.....(130)	8	4	26	2	1	.....	98
Acid phosphates.....(56)	.....	.....	8	.....	4	.....	44
Acid phos. with potash..(55)	.....	.....	35	1	.....	.....	19
Total.....	8	4	69	3	5	.....	161

This shows that out of 250 samples, 161 were of the grade claimed for them, 81 were of a higher grade, and 8 of a lower grade than that claimed for them.

Farmers' Samples of Fertilizers.

In addition to the official samples collected by the Inspector of the Fertilizer Department, there have been analyzed forty-one samples for citizens of the State. Persons wishing analyses made will be saved unneccessary trouble and expense by writing in advance to the Secretary of the Fertilizer Department at the college for copies of the Act of the

Legislature and of the Rules of the Board of Trustees concerning such work. The analyses cannot be made unless the law and the rules are complied with.

Water.

Of the 58 samples analyzed, thirteen were from artesian wells, nine of which were flowing wells.

Ores, Minerals and Other Substances.

Forty-three analyses and assays have been made, but the results are not of sufficient interest to be reported in detail.

Distribution of the Work.

The analyses of fertilizers were made by Messrs. McDonnell and Robertson; the analyses of waters, ores, minerals, etc., chiefly by Messrs. Robertson and Henry, though Dr. Brackett and Mr. McDonnell did a considerable amount of work, making use of all their available time for the purpose. It is with pleasure that I refer to the valuable services which these gentlemen have rendered the Department.

Very respectfully,

M. B. Hardin,
Chief Chemist.

Report of the Botanist.

Dr. H. S. Hartzog, Director:

Sir: Herewith I submit to you a brief report of the Division of Botany for the year ending June 30, 1901.

Respectfully yours,

P. H. Rolf,
Botanist.

Correspondence.

The letters of inquiry took wide range over the field of botany. Almost all the whole range being represented.

Some of the questions required considerable time to answer and others required some Investigation.

In some cases this work is a loss of much time to the Division while in others this correspondence brings to us valuable information.

The inquiries regarding plant diseases are more frequent than formerly. They show the need of bulletins on these subjects.

The Laboratory.

The purchase of a new microscope has facilitated matters of investigation.

Much apparatus needed for investigation can be borrowed from the college when it is not being used by the classes for which it was purchased. This has added much to the facilities during the past year.

The addition of the camera stand and the microscope stand make it possible to produce illustrations for bulletins with the minimum outlay of time.

The most serious drawback to the use of the laboratory was found in that no heat could be secured during vacation and even during the college term the heat was not sufficient for comfort. The amount of radiator service being only one half that of the class-rooms in addition to the room being larger and ceiled in place of being plastered.

Student Labor.

The practice of securing the aid of students who are willing to work and who have a taste for botanical work has been continued. This has worked out most excellently during this year. In this way a number of students have become familiar with the routine of certain lines of work. Much of this student labor has been used in such a way that it will be of permanent value to the institution. Most of the work of preparing a mycological collection has been done by students. Also the work of making a card index of the fungi and the host plants, this is not complete.

In addition to the direct value of this work to the Experiment Station it will have an indirect value in fitting young men to take positions as assistants.

Sweet Potato Rot.

During the fall of 1900 the sweet potatoes suffered much from rotting after they had been gathered. This was made the principal line of investigation and considerable information of a technical nature has been obtained. Practical application can now be begun with considerable degree of confidence of success. With the proper application of the means at hand it seems probable that we will be able to preserve sweet potatoes with the same certainty that we preserve apples and Irish potatoes at a cost of only a few cents per bushel.

Diseases of the Apple and Pear.

Careful observations of the diseases of the apple and pear have been made during the year and the greater portion of the work of preparing a bulletin on this subject was done during December and January.

Cotton Diseases.

The field observations have been continued but the difficulty of proceeding with thorough and practical investigation is the same as formerly, leaving this very desirable and inviting field still beyond reach.

Respectfully yours,

P. H. Rolf,

Botanist.

Report of Veterinarian.

Dr. H. S. Hartzog, Director:

Since I have been connected with the South Carolina Experiment Station I have urged the necessity of work with the cattle disease known as Texas fever. The main features in dealing with this disease are to prevent the infection of cattle not immune to it and to immunize non-immunes when it becomes necessary to place them where they are liable to become infected with the disease.

The first feature named can be accomplished only by

quarantine and a judicious system of policing, and would not come within the province of the Experiment Station. On the other hand the inoculation of cattle not immune to Texas fever when it becomes necessary or desirable to place them where they come into contact with ticks (Boophilus annulatus) which are the conveyors of Texas fever, is a problem for experimental research. By this means many of the technical points regarding the disease are to be determined, and one point now paramount with cattle dealers in this State is the lessening of the disease among native cattle purchased for the feed lots. I am conviced that native cattle which have never carried ticks are just as much subject to Texas fever as if they had been raised in the North. With a view to determining this point I purchased in the vicinity of the Station twelve head of yearlings raised on farms free from ticks. These were inoculated in December 1900, with blood from an old cow carrying ticks. A careful record of the temperatures were kept and in due time all of them showed a temperature reaction, refused food and several became much debilitated. For lack of suitable apparatus, no blood tests were made. In May, 1901, these were put out in pasture where ticks were abundant and up to July 1, 1901, had shown no signs of taking the disease. When the observations are completed a bulletin will be published showing in detail the nature of work and results.

Another line of experimental work conducted is the hypodermic injection of Orecoline for flatulent and spasmodic colic in horses. During the year I have treated about twenty cases in this way and am very favorably impressed with the results. Not a single case thus treated has died and in most of them relief was very rapid. If given in small doses (half grain) the most marked action is to produce a profuse salivation. As the dose is increased the digestive secretions are more and more stimulated, peristaltic action increased and evacuation of bowels follows. In large doses it lowers heart action, renders breathing difficult, and produces profuse perspiration.

Samples of Pyoktauin blue dissolved in 200 parts alcohol have been sent out to several parties over the State for use in the treatment of sorehead (favus) in fowls. Few reports of its use are in yet, but the remedy seems to have been very successful in the cases reported.

During the summer of 1900 I lectured in some fifteen farm-

ers' institutes held in several counties of the State, but was prevented by sickness from participating in the one held at held at the College.

Respectfully submitted,

G. E. Nesom,
Veterinarian.

Clemson College, Jan. 21, 1902.

Report of Horticulturist.

Dr. H. S. Hartzog, Director:

Dear Sir: I respectfully submit the following report of the Horticultural Division of the Station for the year ending June 30, 1901:

Peaches: Forty-six varieties bore a crop of fruit this year, and has afforded an excellent opportunity for comparison of varieties. The crop, however, was not so good as in 1900, and on account of continuous rains, during the ripening period, the fruit did not develop, as well as it would have done under more favorable conditions. Specimen fruits have been preserved of nearly all the leading varieties, and are now on exhibition at the South Carolina Inter-State and West Indian Exposition at Charleston, S. C.

Experiments have been continued in spraying those varieties which are most subject to attack from fungus diseases. Many of our excellent varieties that are nearly always destroyed by disease can be grown to perfection when properly sprayed. Various fungicides have been tested in our experiments in spraying different fruits, but Bordeaux Mixture has continued to give the most satisfactory results.

Apples: During the last two years I have collected apple scions from seedlings that seemed specially promising, and have propagated quite a number of trees for trial in different sections of the State. Four of the seedlings are winter apples of fine quality and keep well until late in February, and one of these seedlings has been kept until June in good condition. Two of the seedlings are superior summer apples that are well worthy of cultivation. For the last four years notes

have been taken on forty-two varieties of apples and each year the fall and winter fruits have been stolen before they reached maturity. It is very discouraging to have valuable experiments ruined in this way and something should be done to protect them if possible.

Pears: The Garber is the only variety that has not been badly injured by blight. The trees of this variety are vigorour and well shaped and have borne full crops of fruit for the last four years. All of the other varieties have been cut back every year on account of the blight, and most of them have been killed to the ground. If this variety continues to be free from blight it will be a most valuable one.

Plums: Many varieties have been tested on these grounds, but the Wild Goose, Roberson, Burbank and Negate have given the most satisfactory results. The later introductions are now being tested.

Grapes: A small vineyard of the new varieties have been planted for comparison with the standard sorts. Several of these new introductions promise to be most valuable. We have continued our experiments in spraying to prevent injuries from various fungous disease. The different methods of pruning and training have also been continued.

Ginseng: Our experiment in growing Ginseng is still under way, and will be continued. The plants have made good growth, and a new lot of plants have been collected and set out.

Experiments with new varieties of small fruits and vegetables will be continued.

Canning: We have experimented with the different methods of canning the following fruits and vegetables: Corn, beans, squashes, okra, tomatoes, peaches, pears, plums, apples and blackberries. Many small canning factories have been put up in different sections of the State and there seems to be a growing interest in the industry.

Potatoes: The following experiments have been conducted and will be continued another year:

Comparison of Northern, Western and Southern grown seed for planting in the South.

Different methods of storing for winter, planting at different depths, mulching and methods of culture.

Comparison of fall, winter and spring planting.

Spraying for leaf blight and treatment to prevent scab.

For two years I have been growing a pea that was found growing wild in the woods a few miles North of the College. I started with one plant and now have sufficient seed to fully test its value as a forage plant. The indications are that it will prove to be a most valuable addition to our leguminous forage plants.

The results of my experiments will be given out at a later date. Very respectfully,

C. C. Newman,
Horticulturist.

The South Carolina Experiment Station in account with The United States Appropriation, 1900. 1901.

DR

To receipts from the Treasurer of the United States as per. Appropriation for Fiscal Year ending June 30, 1901, as per. Act of Congress approved March 2, 1887.	$15000 00	

CR

By Salaries	Abstract 1		$ 7788 95
" Labor	" 2		2315 56
" Publication	" 3		953 22
" Postage and stationery	" 4		106 48
" Freight and Express	" 5		201 56
" Heat, Light, Water and Power	" 6		
" Chemical Supplies	" 7		465 72
" Seeds, Plants and Sundry Supplies	" 8		1057 41
" Fertilizers	" 9		91 33
" Feeding Stuffs	" 10		272 06
" Library	" 11		268 03
" Tools, Implements and Machinery	" 12		81 93
" Furniture and Fixtures	" 13		52 87
" Scientific Apparatus	" 14		99 95
" Live Stock	" 15		67 30
" Travelling Expenses	" 16		431 49
" Contingent Expenses	" 17		15 89
" Buildings and Repairs	" 18		730 25
" Balance			
Total		$15000 00	$15000 00

South Carolina Agricultural Experiment Station.
Supplementary Statement.

To receipts from other sources than the United States for the year ended.	Farm Products	Total
	$783 26	
CR		
By Labor		$317 60
" Freight and Expenses		17 42
" Seeds, Plants and Sundry Supplies		32 76
" Feeding Stuffs		49 35
" Buildings and Repairs		310 80
" Balance		55 33
	$783 26	$783 26

We, the undersigned, duly appointed Auditors of the Corporation, do hereby certify that we have examined the books and accounts of the Treasurer of the South Carolina Experiment Station for the fiscal year ending June 30, 1901; that we have found the same well kept and classified as above, and that the receipts for the year from the Treasurer of the United States are shown to have been $15,000.00, and the corresponding disbursements $15.000.00; for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving no balance.

And we further certify that the expenditures have been solely for the purposes set forth in the Act of Congress approved March 2, 1887.

Signed:

R. W. Simpson,
Chairman of Auditors.

Attest:

P. H. E. Sloan,
Custodian.

FIFTEENTH ANNUAL REPORT

OF THE

South Carolina

Experiment Station,

OF THE

CLEMSON AGRICULTURAL COLLEGE,

FOR THE YEAR ENDING

June 30, 1902.

15 1901
14 1900
13 1899
12

Columbia, S. C.
THE R. L. BRYAN COMPANY.
1902.

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J. S. Newman, *Vice-Director and Agriculturist.*
M. B. Hardin, *Chief Chemist.*
G. E. Nesom, B. Sc., D. V. M., *Veterinarian.*
C. C. Newman, *Horticulturist.*
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C. O. Upton, B. Agr., *Dairy and Animal Husbandry.*
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F. S. Shiver, Ph. G., *Assistant Chemist.*
R. N. Brackett, Ph. D., *Assistant Chemist.*
*C. C. McDonnell, B. S., *Assistant Chemist.*
*B. F. Robertson, B. S., *Assistant Chemist.*
D. H. Henry, B. S., *Assistant Chemist.*
H. Benton, M. S., *Assistant Agriculturist.*
O. M. Watson, *Poultry.*
J. S. Pickett, *Foreman.*
John N. Hook, *Secretary and Librarian.*

*Engaged in Fertilizer Analyses.

CLEMSON COLLEGE, S. C., December 1, 1902.

Hon. M. B. McSweeney, Governor of South Carolina.

Sir: I have the honor to submit herewith the Fifteenth Annual Report of the South Carolina Agricultural Experiment Station, in accordance with the requirements of an Act of Congress approved March 2, 1887, for the Establishment of Agricultural Experiment Stations in connection with the Colleges of the several States, organized under the provisions of an Act approved July 2, 1862.

Respectfully submitted.

P. H. MELL,
President.

REPORT OF THE TREASURER SOUTH CAROLINA EXPERIMENT STATION IN ACCOUNT WITH THE UNITED STATES APPROPRIATION, 1901-1902.

DR.

To Receipts from the Treasurer of the United States as per appropriation for fiscal year ending June 30, 1902, as per Act of Congress approved March 2, 1887 ..... $15,000 00

CR.

	Abstract.	
By Salaries	1	$7,550 58
Labor	2	2,330 41
Publications	3	1,146 63
Postage and stationery	4	189 94
Freight and express	5	304 51
Heat, light, water, and power	6	38 89
Chemical supplies	7	374 81
Seeds, plants, and sundry supplies	8	385 00
Fertilizers	9	265 62
Feeding stuffs	10	375 88
Library	11	189 03
Tools, implements, and machinery	12	192 05
Furniture and fixtures	13	24 90
Scientific apparatus	14	292 18
Live stock	15	804 52
Traveling expenses	16	302 98
Contingent expenses	17	21 25
Building and repairs	18	210 82
Balance		
Total		$15,000 00

SOUTH CAROLINA AGRICULTURAL EXPERIMENT STATION, 1902.

SUPPLEMENTARY STATEMENT.

[This supplementary statement, while not required by law, is desired as an aid in interpreting the account rendered for the United States appropriation. While it will be more useful if made in conformity with the schedule fixed for that appropriation, if this is not practicable such a summary of receipts and expenditures from the sources indicated below as can be conveniently prepared from the books of the station may be sub-

stituted. Whenever practicable, it should be for the fiscal year ended June 30.]

	State.	Local Community.	Individuals.	Fees.	Farm Products.	Miscellaneous.	Total.
DR.							
To Receipts from other sources than the United States for the year ending	$	$	$	$	$1,030 39	$	$
CR.							
By Salaries							$58 33
Labor							33 30
Publications							
Postage and stationery							32 07
Freight and express							17 91
Heat, light, water, and power							
Chemical supplies							
Seeds, plants, and sundry supplies							117 21
Fertilizers							2 00
Feeding stuffs							23 41
Library							
Tools, implements, and machinery							30 75
Furniture and fixtures							
Scientific apparatus							
Live stock							100 00
Traveling expenses							18 80
Contingent expenses							
Buildings and repairs							67 65
Balance							528 96
							$1,030 39

We, the undersigned, duly appointed Auditors of the corporation, do hereby certify that we have examined the books and accounts of the South Carolina Experiment Station for the fiscal year ended June 30th, 1902; that we have found the same well kept and classified as above, and that the receipts for the year from the Treasurer of the United States are shown to have been $15,000.00 and the corresponding disbursements

$15,000.00, for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving

And we further certify that the expenditures have been solely for the purposes set forth in the Act of Congress approved March 2d, 1887.

Signed R. W. SIMPSON,
M. L. DONALDSON,
Auditors.

Attest:
Signed P. H. E. SLOAN, Custodian.

REPORT OF THE VICE-DIRECTOR AND AGRICULTURIST.

Dr. P. H. Mell, Director.

Sir: I respectfully submit the following report of the Agricultural Division of the Department of Agriculture for the year ending June 30th, 1902. The general line of work of this division is the same as shown in the report of last year.

There is much material ready for preparation for publication, embracing results of experiments with wheat, corn, sweet potatoes, sorghum, coarse forage plants, grasses and legumes.

A short bulletin was issued last summer on a "New Method of Preserving Sweet Potatoes," which has attracted general attention. The method solves the problem of preservation and transportation of the sweet potato. I have had many inquiries from dealers who wish to handle them, but no one has prepared to evaporate them on a commercial scale. The work of the Experiment Station ends with the demonstration of the practicability of the method. It now remains for some enterprising capitalist to prepare them on a commercial scale. The process has no restrictions upon it but is free for the use of the public. The next bulletin to be issued will discuss Bermuda grass.

Plant breeding is still the leading line of work in this division. Some important practical results have been realized in the establishment of several varieties of cotton superior to any with which they have been compared.

At the request of the Division of Seed and Plant Introduction of the United States Department of Agriculture, a large

number of three varieties of Truffle oak was planted last spring, to be grown in co-operation with that Department.

The details of the work in all field experiments are conducted by Mr. J. Sam Pickett efficiently and satisfactorily.

Poultry Division.—This division is conducted by Mr. O. M. Watson, a poultry expert, as a part of the Agricultural Division. The same lines of inquiry mentioned in the report of last year are still being pursued, viz:

(a) Comparison of different breeds in egg production.

(b) Comparison of fertility of the eggs of different breeds subjected to the same treatment.

(c) Comparison of different breeds for the production of early broilers.

(d) Comparison of grades from the thoroughbreds of different breeds as producers of broilers.

The usual Institute work was done during the College vacation. Twelve Institutes were held in different parts of the State and one at the College, the latter lasting one week.

Very respectfully,

J. S. NEWMAN,
Agriculturist.

REPORT OF STATE CHEMIST.

CLEMSON COLLEGE, S. C., October 8, 1902.

President P. H. Mell, Director.

Sir: I respectfully submit the following report of the Chemical Department of the Station for the year ending June 30th, 1902:

There has been *completed* and published a chemical study of the *Sea Island Cotton Seed*, by F. S. Shiver. Bulletin 68.

Mr. Shiver has also completed the work on the *Rotation Experiment* referred to in my last annual report, and has finished the investigation of the *Tea Industry* in South Carolina to which reference was made in the same report. These results will be prepared for publication as soon as time permits.

We have also concluded the experiments which have been in progress for the last three years, in conjunction with the Agricultural Department of the station, for the purpose of ascer-

taining if any *injurious* effects are produced on the cotton plant by the use of acid phosphates containing the small quantities of free *sulphuric acid* occasionally found in these goods, or carrying considerable quantities of *spent pyrites* as a filler. In none of the experiments were any injurious results observed.

As to work *proposed,* Mr. Shiver is making a collection of samples with the view of investigating the Tobacco industry in this State. *Miscellaneous and routine* analyses have been made as follows:

One sample of Paris Green for Mr. B. S. Ellis, Zion, S. C.

Seven samples of sorghum juice for the Agricultural Department, and one sample of dried distillers' grains for the Dairy Division of the station.

II.

State Analytical Work.

Following is a report of the work on commercial fertilizers, drinking water, minerals, ores, &c., done at the station under the direction of the Board of Fertilizer Control.

SUMMARY.

	Year Ending June 30, 1901.	Year Ending June 30, 1902.
Official sample of fertilizers	335	313
Farmers' samples of fertilizers	41	38
Waters	58	73
Limestone and marls	4	6
Ores and minerals	23	18
Clays and sands	8	4
Miscellaneous	8	5
	477	457

Official Samples of Fertilizers.

The number of samples analyzed this year is 313. The analyses are given in full in *Bulletin 70 and 73 of this Station.*

Classification.

	1901.	1902.
Complete fertilizers	139	141
Acid phosphates	56	45
Acid phosphates with potash	55	51
Kainits	12	16
Cotton seed meals	60	49
Nitrate of soda	3	3
Sulphate of potash	2	1
Muriate of potash	2	4
Manure salt	1	0
Nitrate of soda with potash	1	1
Ground fish	0	1
Tankage	2	0
Miscellaneous	2	1
Total	335	313

Deficient Samples.

Of the 313 samples analyzed 4 were deficient under the law. In addition to these there were 72 samples which fell below guarantee in one or more constituents, as follows:

In available phosphoric acid	4
In available phosphoric acid and ammonia	1
In potash and ammonia	7
In ammonia	28
In potash	32
	72

The extent to which they fell below guarantee is shown in the following table:

Below Guarantee Per Cent.

	.0-.1.	.1-.25.	.25-.50.	.50-1.	1 & over.
In ammonia	10	13	11	2	0
In available phosphoric acid	1	2	1	1	0
In potash	3	17	11	5	3
	14	32	23	8	3

The deficiencies in these samples were made up in money value by an excess of other ingredients, so that these fertilizers were not deficient under the law. While it is true that in many cases the deficiencies thus made up were slight, yet in others they were considerable, and it is obvious that in purchasing such fertilizers the farmer does not get the ingredients in the proportion he wants or pays for. It is certainly not right when a buyer pays for say 60 pounds of ammonia that he should be furnished with only 40 or 50 pounds and have the money deficit made up to him in phosphoric acid or potash. It is to be remarked that the deficiencies are mainly in ammonia and potash, and that these deficiencies are more numerous than they were last year.

Averages of Analyses.

	1901. Per Cent.		1902. Per Cent.	
	Found.	Guaran.	Found.	Guaran.
Acid phosphates:				
Soluble phosphoric acid...	10.18		10.63	
Reverted " " ...	3.82		3.48	
Available " " ...	14.00	13.02	14.11	13.07
Insoluble " " ...	1.30		1.10	
Total " " ...	15.30		15.21	
Acid phosphates with potash:				
Soluble phosphoric acid...	6.62		7.03	
Reverted " " ...	4.87		4.06	
Available " " ...	11.49	9.98	11.09	10.04
Insoluble " " ...	1.22		1.02	
Total " " ...	12.71		12.11	
Potash soluble in water...	2.65	2.42	2.55	2.47
Complete fertilizers:				
Soluble phosphoric acid...	6.46		6.85	
Reverted " " ...	2.94		2.54	
Available " " ...	9.40	8.09	9.39	8.28
Insoluble " " ...	1.60		1.66	
Total " " ...	11.00		11.05	
Ammonia.....	2.87	2.74	2.84	2.66
Potash soluble in water...	2.47	2.19	2.34	2.10

	1901. Per Cent.		1902. Per Cent.	
	Found.	Guaran.	Found.	Guaran.
Cotton seed meals:				
Available phosphoric acid.	2.38	1.57	2.57	1.47
Ammonia	8.55	7.54	7.93	7.36
Potash soluble in water	1.54	1.00	1.63	1.00
Kainit:				
Potash soluble in water	12.61	12.17	12.85	12.00
Muriate of potash:				
Potash (equivalent)	48.92	49.00	50.54	48.25
Sulphate of potash:				
Potash	49.43	46.50	49.10	45.00
Sodium nitrate:				
Ammonia (equivalent)	18.96	18.00	19.03	18.33

The available phosphoric acid and potash in cotton seed meal were guaranteed in only sixteen samples, but these ingredients were determined in all cases. It will be observed that the average percentage of Nitrogen (ammonia) in the meal is considerably lower than it was last year.

Grades.

In the following table the number of acid phosphates and complete fertilizers of each grade according to guarantee, is placed side by side with the number found by analysis to belong to that grade, fertilizers having commercial values equal to those of schedule grades being classed in those grades.

	High.		Standard.		Low.	
	Claimed.	Found.	Claimed.	Found.	Claimed.	Found.
Complete fertilizers (141)	47	64	88	76	6	1
Acid phosphates (45)	38	39	7	6	0	0
Acid phosphates with potash (51).	13	41	38	9	0	1
Total (237)	98	144	133	91	6	2

These results are due to the following changes in grade ascertained by analysis:

	Low to stan'd.	Stan'd to high.	Low to high.	High to stan'd.	Stan'd to low.	High to low.	No chg.
Complete fertilizers (141)...	5	18	0	0	0	0	118
Acid phosphates (45).....	0	4	0	3	0	0	38
Acid phosphates with potash (51).....	0	28	0	0	1	0	22
Total (237).....	5	50	0	3	1	0	178

This shows that out of 237 samples, 178 were of the grade claimed for them, 55 were of a higher grade, and 4 of a lower grade than that claimed for them.

Farmers' Samples of Fertilizers.

In addition to the samples collected by the Inspectors of the Fertilizer Department, there have been analyzed thirty-eight samples for individual farmers. As these analyses cannot be made unless the law and the rules of the Department governing such work are complied with, persons wishing samples analyzed should write in advance to the Secretary of the Fertilizer Department for instructions.

Water.

Seventy-three samples have been analyzed. Of these, twenty-two were from deep or artesian wells thirteen of which were flowing.

Ores, Minerals and Other Substances.

Thirty-three examinations, analyses and assays have been made. The results are not of sufficient interest to report, for although some of the specimens represent materials of commercial value, the Department is not in possession of any information as to the extent of the deposits from which the samples were obtained. The most interesting of all the specimens is a red clay from near Gaffney quite rich in tin ore (Cassiterite). As far as we have heard, no well defined vein of the ore has been discovered.

Distribution of Work.

The analyses of fertilizers were made by Messrs. McDon-

nell and Robertson, the analyses of water by Messrs. McDonnell and Henry, the analyses and assays of minerals, ores, &c., by Messrs. Robertson and Henry. I desire to express my appreciation of the services which these gentlemen have rendered the Department.

In the duties of the office I have had the assistance of Dr. Brackett to whom my acknowledgments are due for carrying on the work so faithfully during my absence last summer.

Very respectfully,

(Signed) M. B. HARDIN,
Chief Chemist.

REPORT OF THE VETERINARIAN.

To Dr. P. H. Mell, Director:

The report of the Veterinary Division for the year ending June 30, 1902, is as follows:

The work of this division has been practically limited to the inoculation of cattle to immunize them against Texas fever and a study of the outbreaks of this disease in several herds of the State. The work may be divided into four classes:

First. The inoculation of Northern cattle when shipped to this State. A car-load of registered Short-horn, Hereford and Aberdeen Angus cattle were shipped to the station in November, 1901, and inoculated, part of them receiving two, part three and part four injections of defibrinated blood within 90 days. While the reactions were not considered typical at the time, one Hereford bull contracted the acute type of fever and died. There was but little disturbance in any of the others. All but two were shipped to different parts of the State, and all of them have been exposed to ticks for several weeks with no bad results. Three head from Kentucky were also inoculated. Another car-load will be shipped here from the same point during the latter part of October, 1902, and will be inoculated in the same way. These cattle are bought as breeding stock by residents of the State. The fact that they have been successfully immunized has served to stimulate an interest in beef breeding, a much neglected industry.

Second. The inoculation of grade cattle bought for breeding purposes, their origin being unknown. Since the renewal of interest in beef breeding, a few consignments of beef cattle have been sold in the State, and while they are not very valuable, the purchasers often request that they be inoculated. In most cases they are handled by stock dealers and nothing is known of their origin, but the most of them so far inoculated have reacted. While little encouragement is offered by this division to purchasers of this class of stock, they are no doubt a necessary link in the movement toward high class beef breeding.

Third. The inoculation of native cattle. This is a phase of the work heretofore much neglected by those who have been inoculating cattle. The excessive losses observed directed attention to the necessity for some source of relief. The loss of native cattle lost last year in the State from Texas fever alone amounted to an estimated money value of $122,000. Twelve head of native calves known to have been raised free from ticks were inoculated in the fall of 1900, and all but one survived the entire year 1901 in an infested pasture. In March, 1902, forty head of native cattle were selected from four herds and inoculated, though only about half of them gave positive reactions. During the spring they were allowed to run with the herds from which they were taken, and while a few of those not inoculated have died, all of those inoculated have survived.

Fourth. Study of outbreaks of Texas fever. Ticks survive in many parts of this State all winter, one cow on the College farm being badly infested February 10, 1902, when there was twelve inches of snow on the ground. During the stock show at the Charleston Exposition, January 6 to 20, 1902, about one-eighth of the cattle shown there became infested with ticks and twenty-five head of Northern and native cattle died. From the best evidence obtainable it seems that the young ticks had hibernated in rice straw used as bedding or the native hay fed to the cattle, or possibly both. Several outbreaks have been observed in native tick-free herds into which ticks had been recently introduced by purchase of infested cattle. Some have been in cattle raised in towns and sent to pastures in the country where ticks abound.

Some of the minor experiments in progress have been continued, among which may be mentioned the Schmidt treatment for parturient paresis by means of a special injector which prevents the introduction of air into the udder; painting the heads of chickens affected with "sore-head" (favus) with a 1-200 alcoholic solution of pyoktanin blue; the hypodermic injection of arecoline hydrobromate for flatulent colic in horses; and a new experiment, the treatment of dermomycosis in calves by spraying with coal tar disinfectants (chloro-naptholeum and zenoleum).

Respectfully submitted,

G. E. NESOM,
Veterinarian.

REPORT OF THE HORTICULTURIST.

Dr. P. H. Mell, Director.

Dear Sir: I respectfully submit the following report of the Horticultural Division for the year 1902:

The following experiments that have been under way for the last three years are about complete, some of which will be continued:

Potatoes—Comparison of Northern, Western and Southern grown seed for planting in the South. Comparison of fall, winter and spring planting. Different depth of planting, mulching and methods of culture.

Celery—Testing varieties, methods of blanding and keeping through winter. Spraying to prevent leaf blight.

Strawberries—Spraying for rust; testing new varieties, methods of culture, mulching, &c. Brandywine, Lady Tompson, Hoverland and West Lawn continue to give best results in our variety tests.

Tomatoes—Pruning and training, testing of varieties, spraying for blight and potato bug. This year for the first time the potato bug has attacked tomato vines, and it was necessary to spray the vines with paris green to destroy them.

Cantaloups.—Testing varieties and methods of planting.

Onions—Planting seed and sets in fall have been compared with planted in spring and the results are much in favor of fall planting.

Ginseng—Our experiments in this plant have been very encouraging. More plants have been collected from the mountains and next year our bed will be much increased. The plants set three years ago produced a fine lot of seed this year, all of which have been planted.

Ruta Baga—Experiments in thinning and time of planting. Rows 3 feet apart with plants every 14 in. gave heaviest yield and largest and most uniform roots.

Seed planted the last week in August made roots weighing from four to seven pounds by fifteenth of November.

Various methods of keeping until spring have been listed for the last three winters. Banking the roots in the field has proven to be the most satisfactory method of keeping. They keep perfectly fresh and sound until spring.

Apples—I have collected six more seedling apples that seem well suited to this section. I now have twenty-two seedlings all of which are well worthy of cultivation, and some will prove valuable for the winter market.

Spraying experiments have been continued for the following pests of the orchard and garden: Codlin moth, scale insects, bitter rot, apple scob, brown rot of peaches and plums, and various diseases of the grape.

Experiments with peaches, plums and grapes mentioned in my last report have been continued.

I would like to call your attention to the greenhouse. I have patched one of the houses so as to keep the plants through winter, but the entire structure is very unsafe, and will have to be remodeled before another winter.

Very respectfully,

C. C. NEWMAN,
Horticulturist.

REPORT OF THE ENTOMOLOGIST.

Dr. P. H. Mell, Director.

Dear Sir: Since August 26, 1901, the date of my appointment, I have devoted much of my time to the classification of the insects that have been collected during the past two or three years. I have also provided furniture that will insure the preservation of this collection which fairly represents the local fauna. From my correspondents and from my field work in different parts of the State, I shall soon secure a representative collection of the injurious insects of South Carolina.

It is gratifying to report that through my correspondence and institute work, I have succeeded in interesting many in the spraying of fruits, and that through the State Horticultural Society, which I organized last year, I have arranged co-operative work with its members, which will enable me to demonstrate most satisfactorily the economy of a systematic warfare against insects.

I have learned from one year's correspondence that the habits of the common insects are not well understood, and to supply this information which is so much needed for the intelligent application of the remedial and preventive measures that are used in fighting these insects, I would suggest the publication of three bulletins, dealing respectively with the insects of the garden, orchard and field crops.

As the peach is grown upon a large commercial scale in this State, I have begun a study of the noxious insects of this fruit, principally for the purpose of encouraging those who feel that against the scale insects, especially the San Jose, their efforts are futile. A preliminary study is also being made of the insects of tobacco and rice.

Having no other room than that in which my class work is conducted, I am laboring at a great disadvantage in the study of the life histories of our injurious insects. For accurate investigations along this line, I should be provided with a conservatory for the rearing of insects, similar to that which is used for plants, though smaller. Such a building would enable me to control the conditions of growth of both plants and insects, and to secure more valuable data, and in a shorter time,

too, than if I depended entirely upon field observations, which cannot always be made at the proper time, owing to the distance of the fields and orchards from the college building. I am also in need of a room for the storage of spraying machinery and insecticides.

Respectfully submitted,

Chas. E. Chambliss,
Entomologist.

Report of the Botanist and Bacteriologist.

Dr. P. H. Mell, Director:

I beg to make the following report:

During the College year 1901-1902 the office of Botanist was vacant. This report, therefore, covers only the period of my incumbency, August 26, 1902, to date.

During the interregnum the herbarium suffered somewhat from the ravages of insects; I have accordingly found it necessary to devote much time to putting it into proper condition.

A serious contagious disease of poultry, supposed to be bacterial, is my principal subject of investigation at the present time. This disease appears to have caused serious loss in this State, not only this year, but for some years past. It is yet too early to make even preliminary report of my investigations.

I intend to concentrate my efforts for the remainder of the year on the study of two little known diseases of plants—the "frog-eye" leaf spot of tobacco, and the so-called "blast" of rice. Several important diseases of cotton should be investigated, but this can hardly be done with the facilities now at my disposal.

In beginning my work, I find myself greatly hampered by the lack of a propagating house for the study of plant diseases; and by the unfitness of the bacteriological laboratory for cultural work. As my predecessor has already discussed these conditions in the last two annual reports, I need only to say that I endorse his statements and recommendations.

Respectfully submitted,

Haven Metcalf,
Botanist and Bacteriologist.

Report of the Division of Animal Husbandry and Dairying.

Clemson College, S. C., November 8th, 1902.

Dr. P. H. Mell, Director.

Dear Sir: I have the honor to submit the following report of the Division of Animal Husbandry and Dairying for the fiscal year ending June 30, 1902:

The experiment to test the relative feeding value of corn stover and cotton seed hulls was continued during the winter, and data obtained in addition to those already published.

During the summer a new dairy barn was planned and is now in process of erection and equipment. This barn is intended as a model dairy barn, and will have all modern improvements. Illustrations of these improvements will be published in a special bulletin.

During April four new bulls were added to our stock of pure bred animals of the following breeds: Guernsey, Hereford, Polled Angus and Dairy Shorthorn. The service of these animals is free to all farmers who wish to avail themselves of the opportunity to improve their stock.

During the Institute at the College in the summer the dairy was run each afternoon to illustrate to those in attendance modern methods of handling milk and the making of butter and cheese. Lectures were also given before the general Institute.

A State Dairyman's Association was also formed, and all interested in dairy work thus brought in closer communication.

Respectfully submitted,

C. O. Upton,
Dairyman.

Synopsis of Bulletins.

No. 65, July, 1901, San Jose Scale, with a few suggestions for its treatment, and rules and regulations adopted by the State Board of Entomology. 12 pages.

No. 66, February, 1902. Feeding Corn Stover. Dehorning milk cows. 9 pages.

No. 67, March, 1902. Stock Feeding, showing the number

of pounds of digestible nutrients in 100 lbs. of American feeding stuffs, giving also feeding standards. 13 pages.

No. 68, March, 1902. A Chemical Study of the Sea Island Cotton Seed, discussing the structure of the seed and the chemical analysis of the same, showing the amount of oil and the constituents of the hulls and meal and the feeding values. 90 pages.

No. 69, March, 1902. Brown Rot of Peaches and Plums. Giving cost of spraying with a preparation of the spraying material, importance of destroying decayed fruits. 12 pages.

No. 70, April, 1902. Analyses of Commercial Fertilizers for the season of 1901-1902. 24 pages.

No. 71, May, 1902. A New Method of Preserving Sweet Potatoes. 6 pages.

OF THE
UNIVERSITY OF ILLINOIS
27 APR 1915

SIXTEENTH ANNUAL REPORT

OF THE

South Carolina Experiment Station,

OF THE

CLEMSON AGRICULTURAL COLLEGE,

FOR THE YEAR ENDING

JUNE 30, 1903.

COLUMBIA, S. C.
THE STATE COMPANY.
1904.

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J. S. PICKETT, *Foreman.*
JOHN N. HOOK, *Secretary and Librarian.*

*Engaged in Fertilizer Analyses.

CLEMSON COLLEGE, S. C., December 1, 1903.

Hon. D. C. Heyward, Governor of South Carolina.

Sir: I have the honor to submit herewith the Sixteenth Annual Report of the South Carolina Agricultural Experiment Station, in accordance with the requirements of an Act of Congress approved March 2, 1887, for the Establishment of Agricultural Experiment Stations in connection with the Colleges of the several States, organized under the provisions of an Act approved July 2, 1862.

Respectfully submitted.

P. H. MELL,
President.

The South Carolina Experiment Station in Account with the United States Appropriation, 1902-1903.

Dr.

To Receipts from the Treasurer of the United States as per appropriation for fiscal year ended June 30, 1903, as per act of Congress approved March 2, 1887 ..... $15,000 00

Cr.

		Abstract.	
By Salaries	1	.....	$8,579 76
Labor	2	.....	2,244 55
Publications	3	.....	935 13
Postage and stationery	4	.....	159 58
Freight and express	5	.....	227 85
Heat, light, water and power	6	.....	101 42
Chemical supplies	7	.....	378 90
Seeds, plants, and sundry supplies	8	.....	298 17
Fertilizers	9	.....	136 38
Feeding stuffs	10	.....	84 47
Library	11	.....	194 66
Tools, implements and machinery	12	.....	121 65
Furniture and fixtures	13	.....	58 60
Scientific apparatus	14	.....	75 10
Live stock	15	.....	227 65
Traveling expenses	16	.....	574 54
Contingent expenses	17	.....	15 00
Buildings and repairs	18	.....	586 59
Balance			
Total			$15,000 00

We, the undersigned, duly appointed Auditors of the corporation, do hereby certify that we have examined the books and accounts of the Treasurer of the South Carolina Experiment Station for the fiscal year ended June 30, 1903; that we have found the same well kept and classified as above, and that the receipts for the year from the Treasurer of the United States are shown to have been $15,000.00, and the corresponding disbursements $15,000.00, for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving no balance.

And we further certify that the expenditures have been solely for the purposes set forth in the act of Congress approved March 2, 1887.

(Signed) R. W. Simpson,
[Seal.] M. L. Donaldson,
Auditors.

Attest:
P. H. E. Sloan,
Custodian.

SOUTH CAROLINA AGRICULTURAL EXPERIMENT STATION, 1903.

SUPPLEMENTARY STATEMENT.

[This supplementary statement, while not required by law, is desired as an aid in interpreting the account rendered for the United States appropriation. While it will be more useful if made in conformity with the schedule fixed for that appropriation, if this is not practicable such a summary of receipts and expenditures from the sources indicated below as can be conveniently prepared from the books of the station may be substituted. Whenever practicable, it should be for the fiscal year ended June 30.]

	State.	Local Community.	Individuals.	Fees.	Farm Products.	Miscellaneous.	Total.
DR.							
To Receipts from other sources than the United States for the year ended.	$....	$....	$....	$....	$....	$....	$1,687 63
CR.							
By Salaries	$....	$....	$....	$....	$....	$....	.....
Labor	.....	.....	.....	.....	.....	.....	202 05
Publications	.....	.....	.....	.....	.....	.....	.....
Postage and stationery	.....	.....	.....	.....	.....	.....	.....
Freight and express	.....	.....	.....	.....	.....	.....	4 17
Heat, light, water and power	.....	.....	.....	.....	.....	.....	1 16
Chemical supplies	.....	.....	.....	.....	.....	.....	.....
Seeds, plants, and sundry supplies	.....	.....	.....	.....	.....	.....	17 58
Fertilizers	.....	.....	.....	.....	.....	.....	.....
Feeding stuffs	.....	.....	.....	.....	.....	.....	82 58
Library	.....	.....	.....	.....	.....	.....	.....
Tools, implements, and machinery	.....	.....	.....	.....	.....	.....	42 85
Furniture and fixtures	.....	.....	.....	.....	.....	.....	9 00
Scientific apparatus	.....	.....	.....	.....	.....	.....	14 30
Live stock	.....	.....	.....	.....	.....	.....	413 26
Traveling expenses	.....	.....	.....	.....	.....	.....	.....
Contingent expenses	.....	.....	.....	.....	.....	.....	.....
Buildings and repairs	.....	.....	.....	.....	.....	.....	3 40
Balance	.....	.....	.....	.....	.....	.....	897 28
							$1,687 63

Report of the Vice-Director and Agriculturist.

Clemson College, S. C., December 10, 1903.

Dr. P. H. Mell, President and Director.

Dear Sir: I have the honor of presenting the following report of the work of the South Carolina Experiment Station during the fiscal year ending June 30, 1903:

AGRICULTURAL DIVISION.

The results of artificially cross-breeding cotton have proved eminently satisfactory. Some of these new varieties are sufficiently well established in fixedness of type to be distributed in small quantities for trial in other parts of the State. Experiments were continued with grasses and legumes, with varieties of wheat, varieties of peas, etc. Experiments were made with different sources and forms of potash to test their effects upon the burning quality of tobacco.

Exhaustive experiments were made with sorghum. These will be repeated to secure average results in different seasons.

Cooperation with United States Department of Agriculture.

Comparison of different varieties of corn in triplicate in cooperation with the Division of Plant Industry of the United States Department of Agriculture.

Growing truffle oaks for the same division was continued.

Specimens of three breeds of pure-bred swine have been secured for comparison *inter se* and for comparison of their crosses as pork producers. Growing crops to be harvested by hogs has been continued. Unfavorable seasons through the entire growing season militated against all experiment work. Assistant Prof. Benton and Mr. J. S. Pickett, foreman of experiment grounds, have rendered valuable and efficient service.

REPORTS OF CHIEFS OF DIVISIONS.

Dr. G. E. Nesom, Veterinarian, has submitted the following report of his work, which I present entire.

REPORT OF VETERINARIAN.

Prof. J. S. Newman, Vice-Director.

Sir: The following report of the work of the Veterinary Division for the year ending June 30, 1903, is respectfully submitted.

Diseases of Horses.—Glanders in horses and mules has prevailed in several counties, but most of the outbreaks have been small, involving from one to ten animals. A number have been tested with mallein, and the reacting animals that showed marked physical signs of the disease were killed. The records of the tests with notes on the outbreaks have been preserved, and will be issued in bulletin form at some future time.

Leuco-encephalitis or cerebro-spinal meningitis (a form of the so-called "staggers") has prevailed to an alarming extent. It was worst in the late summer and fall, continuing up to about March. It was not limited to any special part, but occurred in nearly half of the counties of the State. Numerous visits were made to investigate outbreaks, but unfortunately in most cases the animals were dead, and the carcasses disposed of on the arrival of the inspectors. As the owners generally had not made careful observations of the symptoms, it was not until numerous post mortem examinations had been made, and the brains carefully studied, that the disease was positively diagnosed. Several of the brains were sent to Washington and examined by Dr. John R. Mohler, Pathologist of the Bureau of Animal Industry. This division was greatly aided in the work by his cooperation and assistance. The cause of the disease seemed to be the indiscriminate use of damaged foods, such as decayed corn and moldy hay.

No accurate estimate can be placed on the damage to horse owners in the State from this disease, but from reports on file in this office, it certainly was not less than $10,000 during six months—September 1, 1902, to March 1, 1903.

As no funds were available for the work, no investigations were made further than to diagnose the disease and warn the owners against the further use of the feed stuffs which seemed to be the cause. It may not be out of place to add that this disease has prevailed all along the Atlantic and Gulf coasts

from New York to Texas for fifty years, and has at times caused serious damages in all the States of this region. Very little has been done toward investigating its nature, cause and prevention.

Diseases of Cattle.—Texas fever has been given more attention than any other disease. In the fall when beef cattle began to move to the feeding pens of this State, there occurred several outbreaks of the disease among North Carolina and Tennessee cattle shipped to the middle and lower portions of this State. The bulk of them were raised in the mountains, not many miles above the quarantine line, which marks the northern boundary of the tick-infested section.

They were therefore subject to the fever, and as a result of bad management in shipping some of them became infested with ticks.

Practically all that contracted the disease died, and the loss was something like $4,000.

Such outbreaks clearly show that southern-raised cattle are no more immune to the disease than northern cattle, if they have not actually carried ticks at some time in their lives.

Inoculation.—As planned, a carload consisting of thirty-two head of northern cattle were shipped to the station in October, 1902. They consisted of nineteen registered bulls and heifers under two years old and thirteen high-grade yearling heifers.

Reactions were perfect, the cattle were shipped to their owners and up to the end of the time this report includes all were doing well except one yearling shorthorn bull, which is reported to have died from Texas fever about ninety days after shipment.

In February and March this division inoculated sixty-two head of grade yearling Shorthorn, Hereford and Aberdeen Angus cattle shipped to Hicklins, Rock Hill and Batesburg. The reactions were excellent and all of the cattle seemed to have been protected when exposed to ticks.

Two or three deaths among them are reported as resulting from scours and other causes than Texas fever.

The total number of cattle inoculated up to date is 212 head, and the death rate among them from Texas fever during and

after inoculation has been less than two per cent; while the death rate among northern cattle similarly exposed but not inoculated is generally over fifty per cent.

Hog Cholera.—During the fall and winter this disease appeared in several parts of the State. In several cases the infection could be traced directly to shipments of hogs from East Tennessee. This disease is a serious menace to the hog-raising industry of the State, and so far nothing of importance could be done to check its ravages except to visit sections where outbreaks actually existed, quarantine the infected farms and recommend sanitary measures.

Publications.—During the summer of 1902 bulletin No. 72, "Texas Fever, Part I," was issued, giving a general account of the disease. A number of circular letters and newspaper articles were written on special subjects where bulletins would not serve the purpose. "Texas Fever, Part II—Inoculation," is now in course of preparation.

Respectfully submitted,

G. E. NESOM,
Veterinarian.

December 10, 1903.

The time of both Veterinarian and Entomologist is so much occupied with field work required by State law that systematic investigation in their respective lines is seriously interrupted.

REPORT OF THE ENTOMOLOGIST.

Prof. J. S. Newman, Vice-Director South Carolina Experiment Station.

Sir: During the latter part of March, at the request of representative men and by order of the Department, I visited Darlington and adjoining counties to aid the farmers in fighting the grain louse *Nectarophora avenae* Fabr., which had appeared in the oat fields in unusual numbers. During my first day's study in the field, I discovered that the natural enemies of the louse had increased to such a degree that, if remedial measures were discontinued, the parasitic and predaceous

insects would check the increase of the louse more effectively than any artificial means that could be devised. I announced this at once to save further expense to the farmers, who, in many cases, were broadcasting lime and calcined marl—insecticides, which at their best could only destroy a small percentage of the lice. The results of this field work are reported in a bulletin which is now being prepared.

In cooperation with the Bureau of Chemistry, United States Department of Agriculture, I have conducted spraying experiments for the determination of the amount of arsenious oxid in paris green that can be endured by the foliage of peach, plum, pear and apple. The notes on this work have been forwarded to the proper authorities.

The study of the Boll Worm, *Heliothis armiger,* Huebner, which was being conducted under the direction of the Division of Entomology, United States Department of Agriculture, for the purpose of assisting in mapping out the number of broods and time of appearance of this insect throughout the cotton belt, was discontinued on account of the interruption caused by the Institute work. I refer to the cause of the discontinuance of this work, believing that if brought to your notice an effort will be made to prevent its occurrence again, as such interruptions seriously interfere with the solution of any entomological problem.

Through the State Horticultural Society, the Institutes and correspondence (the latter of which without clerical help is becoming very burdensome), I have been enabled to present in a popular way the economic bearing of entomology.

The unexpected presence of the Mexican Cotton Boll Weevil in Louisiana has caused such uneasiness in South Carolina that the greater part of my correspondence since early August has been upon this insect. Insects of all kinds found upon cotton, especially the boll worm, have been received for identification, but no specimens of the weevil, except a half dozen which were received from a South Carolinian who had imported them from Texas. Our people should be warned against such a practice, and to reach all who may be tempted to do likewise I have prepared for the State press an illustrated article on this pest, to be published in early spring.

In conclusion, I wish to emphasize my recommendations of last year relative to suitable quarters for the study of the life histories of injurious insects. Yours respectfully,

CHAS. E. CHAMBLISS,

December 9, 1903. Entomologist.

REPORT OF THE HORTICULTURIST.

Prof. J. S. Newman, Vice-Director.

Sir: I respectfully submit the following report of the Horticultural Division of the Station for the year ending June 30, 1903.

We have continued to take notes on the varieties of apples growing in the horticultural grounds, and now have notes on these varieties for the past five years. From these notes we are able to recommend certain varieties that have proven to be best suited to this section of the State.

The following varieties have given good results and are to be recommended:

Winter Varieties—Ben Davis, Yates, Winesap, Shockley, Mangum, Scott's Cluster, Kittagiskee, Stevenson's Winter.

Summer Varieties—Early Harvest, Yellow Transparent, Red June, Julian, Carolina Watson, Hominy, Mrs. Bryan.

Many standard varieties that have not been listed here have been planted; we have also secured several more seedling apples from the mountain section, in addition to those mentioned in my last report. Some of these seedlings are of excellent quality, and the trees vigorous and very productive. These varieties promise to be of much value. They are now being propagated and will be tested in different sections of the State.

Peaches.—Many of the varieties of the peaches tested have proven to be of no value for this section of the State, while others have given good results and are to be highly recommended. Out of sixty varieties only one-third of that number have proven worthy of cultivation. The following list of varieties have proven to be well suited to this section and are highly recommended:

Variety of peaches.	
Greensboro	S.-C.
Early Tillotson	F.
Early Louise	S.-C.
Yellow St. John	F.
Mountain Rose	F.
Lady Ingold	F.
General Lee	C.
Stonewall Jackson	C.
Elberta	F.
Thurber	F.
Globe	F.
Chinese Cling	C.
Stump the World	F.
Lemon Cling	C.
Bordeaux	C.
Eaton's Golden	C.
Bilyen's October	F.

Note.—F., Freestone; S.-C., Semi-Cling; C., Cling.

The above list of varieties will furnish ripe fruit continuously from the first of June to the last of October. Some of these varieties frequently rot very badly, but we have been able to prevent this disease by spraying with Bordeaux mixture.

Some of the old trees that have proven worthless have been removed and a young orchard of standard varieties set out. A good many new varieties that have recently been introduced are being tested.

Pecans.—Fifty-five of the seedling pecan trees bore a few nuts this year, and I am sorry to say that not one of these trees has borne fine nuts. No two trees have borne fruit alike; they vary greatly in shape, size and quality. The best nuts produced are only about one-third the size of the standard varieties. From some of these trees it required 192 nuts to make one pound, and the best seeding tree that bore nuts required 80 to the pound, while it requires only from 25 to 35 nuts of the best varieties. This goes to show that the pecan varies from seed equally as much as the peach, and it is there-

fore necessary, if fine nuts are desired, that some standard varieties be either budded or grafted on the seedling.

Grapes.—The variety vineyard bore no fruit this year on account of the freeze last spring, which killed all the fruit while in bloom. This is the first year the grapes have failed to bear a full crop.

The vines are in good condition, and I hope to have eighty-four varieties on exhibition next summer during the Institute.

Variety and culture tests have been continued with the following vegetables: Celery, cabbage, cauliflower, tomatoes, onions, canteloupes, eggplants and peppers.

The variety and culture tests have also been continued with blackberries, raspberries and strawberries.

Irish Potatoes.—The experiments we have had under way for the last three years with potatoes have been continued.

1. Comparison of northern, western and southern grown seed for planting in spring and fall.
2. Comparison of fall, winter and spring planting.
3. Different depths of planting and culture.
4. Methods of keeping spring and fall crops.
5. Test of varieties.
6. Treatment of tubers before planting to prevent scab.
7. Spraying for insect enemies and diseases of the potato.

Very respectfully,

C. C. NEWMAN,

December 5, 1903. Horticulturist.

REPORT OF THE BOTANIST AND BACTERIOLOGIST.

Prof. J. S. Newman, Vice-Director South Carolina Experiment Station.

I beg to submit the following report:

Correspondence.—During the year ending September 1, 1903, 1,580 official letters have been written by the Botanist. As there is no stenographer at the service of the station officials, anyone familiar with the details of correspondence can readily calculate how much time and effort have been consumed in the merely mechanical part of this work, aside from

the technical studies necessary in order to answer the questions. This correspondence has been principally concerned with the identification of forage plants and seeds, the identification and treatment of plant diseases, within the State; inquiries from outside regarding agricultural and botanical facts within the State; requests from teachers for identification of plants, and for facts and literature bearing upon nature study. This last class of correspondence is largely on the increase, and I recommend that some general action be taken to supply such information by issuing "nature study bulletins," as is done in many States, or by some other means. As the library of this division is very limited, containing few of the books necessary for the identification of any but the commonest forage plants and fungous diseases, it is often necessary to secure the loan of literature from the libraries of other stations, or the United States Department of Agriculture, before letters can be answered. This sometimes involves a delay of a month or six weeks, which must be very irksome to the correspondents.

Herbarium.—Every plant or disease, once identified, is preserved in the herbarium, which thus is becoming an invaluable reference collection, in teaching as well as in the work of the station. It is my purpose to place in the herbarium a specimen of every plant of economic value which grows in the State, as well as, in time, to make it representative of the native flora. Arrangements are being perfected with a number of amateur collectors in the State whereby they, in return for various assistance, will deposit duplicates of their collecting in the herbarium.

Student Labor.—In the herbarium work especially, and in other lines, student assistants have been employed as heretofore. The work has been very satisfactory. Especial mention should be made of the excellent service rendered by Mr. T. B. Young of the Class of 1903, now in the employ of the United States Department of Agriculture, and by Cadet H. W. Barre of the present Junior Class.

Investigations.—In my last report I stated that my lines of investigation were (1) a contagious poultry disease ("limber neck," so called), (2) leaf spot of tobacco ("frog-eye"), and (3) "blast" of rice.

Investigations of the poultry disease were continued through the year, and while they were far from complete when work ceased, the following provisional results were arrived at. The disease is an entero-hepatitis, the most characteristic post mortem symptoms being marked inflammation of the intestinal tract, with degeneration and congestion of the liver tissue. Though apparently contagious the disease is not bacterial. The occurrence of the disease is invariably associated with the prevalence of a certain fly, which lays its eggs in the feathers. Experiments indicated that fowls kept from this fly did not contract the disease, whereas those kept under exactly the same conditions, but not protected from the flies, contracted the disease and died. Hence the indications are that the disease is of the same general aetiology as malaria, yellow fever and Texas fever of cattle; but the experiments were too few in number to warrant the drawing of absolute conclusions. The disease is popularly confused with several other poultry diseases; not more than sixty per cent. of all the poultry brought to the laboratory for post mortem examination had died from this distinct disease. This investigation ceased, of necessity, with the abolition of the poultry division.

Laboratory studies of the spot diseases of tobacco were carried on for several months, then discontinued; as the entire question of tobacco diseases in this State has been taken up by the United States Department of Agriculture.

Investigations of the rice blast and other rice diseases have been my principal work. In this station the blast is by all odds the most serious rice disease, and is even threatening the existence of the rice industry in certain localities. One bulletin on this subject has already been issued by this station. Both of my predecessors investigated the disease, but as they left before arriving at final conclusions their work is practically lost. My results so far indicate that the disease is of fungous origin, and that it can be controlled by the same methods that have been employed with cotton wilt, i. e., selection of seed from immune stalks.

Greenhouse.—It is no exaggeration to say that my working capacity would be doubled, so far as plant diseases are concerned, if I had access to a greenhouse. With this addition to

my equipment, practical work in inoculation and immunity studies could be carried on as well in the winter as in the summer. For lack of this it is impossible to even attempt the study of the diseases of our staple crop, cotton, or the diseases of many truck crops, such as asparagus, tomatoes and melons.

Seed Testing.—Work has been in progress in the division for about six months on the question of the purity and vitality of the seed supply of the State, especially grass, grain and clover seed.

Diseases of Plants.—As a full account of the plant diseases that have appeared in the State during the past year is being prepared for publication in the Yearbook of the United States Department of Agriculture, I purposely omit that account here.

Institutes.—During the summer I lectured at seven farmers' institutes through the State, and I participated in the Institute held at Clemson.

Proposed Work.—For the coming year I shall concentrate my efforts upon the disease of rice, especially the blast; shall continue the seed examination, investigate the whole question of storage and keeping qualities of sweet potatoes.

Bulletins.—Three bulletins are in preparation on the following subjects: Seed purity and vitality, the commonest plant diseases and their treatment, sanitary conditions on the farm. The last will very shortly be ready for press.

Respectfully submitted,

Haven Metcalf,

Botanist and Bacteriologist.

December 4, 1903.

Report of Dairy and Animal Husbandry.

Prof. J. S. Newman.

Dear Sir: I beg to submit the following report of the Division of Animal Husbandry and Dairying.

In the annual report of last year it was announced that an ideal dairy barn was under way of construction. Since that time the building has been completed and is now occupied by a herd of pure-bred cattle consisting of Jerseys,

Ayrshires, Devons and Shorthorns. As it was impossible, with the limited means at hand, to buy many costly animals, it was the policy of the management to buy a few select cows and a choice bull of each of the above named breeds and begin breeding. The cattle are all in good condition and have been bred successfully. We have at present two small pastures and a number of paddocks under fence and partly sodded, but we hope during this winter to enclose two more pastures and to continue sodding and sowing grass, so that when our herds reach the desired size we will have ample first-class pasturage for them and will also be able to show what kind of pasture can be made on our "worn out" hills.

Owing to our limited number of cattle and to a lack of their uniformity, no experiments have so far been conducted. An experiment to determine the effects of long and continuous feeding of cottonseed meal to cattle (milch cows) has been planned and will be begun in a few days. It is believed by some authorities that cottonseed meal when fed to milch cows in large quantities for a long period of time will produce abortion, barrenness and other abnormal troubles. It is, therefore, the object of this experiment to determine, if possible, what injurious effects will result and the extent of such injuries.

Four healthy grade cows of average constitution and size have been procured, all of which have proven themselves to be sure breeders. They will be fed heavily on cottonseed meal rations throughout all periods of pregnancy and lactation. We hope to be able to continue this experiment indefinitely, so as to obtain data that will enable us to either advocate or condemn the extensive feeding of this very common foodstuff.

We hope by spring to be able to conduct some feeding experiments with a group of pure-bred cattle. This cannot be determined until we find what their condition will be at that time.

A small exhibit of our cattle was made at the State Fair last fall, and while there our surplus bulls were sold. We hope to repeat this exhibit next year and again offer for sale a fine lot of young pure-bred bulls.

In our dairy building one room is now being equipped with modern hand machinery for milk separation and butter

making, and we wish here to express thanks to the DeLaval Separator Company, the Vermont Farm Machine Company, and to Mr. P. M. Sharples for the use of the hand separators they have each placed with us for this season.

Work is now in progress on a bulletin that will demonstrate the importance of the milk-sheet, the milk scales and the Babcock test, and give sufficient explanation of how the Babcock test is made, so as to enable any farmer to test each cow in his herd and determine whether or not she is a profitable animal.

Respectfully submitted,

B. H. Rawl,

Acting Dairyman and Animal Husbandman.

The chiefs of Divisions are all doing satisfactory work as far as their facilities permit. We are undertaking more work than the means at command justify.

FARMERS' INSTITUTES.

During the last spring and summer forty local Institutes were held, with an aggregate attendance of about 10,000. The attendance on the State Institute, held at the College, was estimated at 1,500. Seven members of the Agricultural Department participated in the exercises of these Institutes.

COAST EXPERIMENTS.

In accordance with the orders of the Board of Trustees, experiments have been conducted with asparagus and sea island cotton on James Island, and with rice on Cooper River. Illustrative work with grasses and forage plants has been done on a plot originally embraced in the exposition grounds. The latter experiments have already stimulated the farmers of that section to increased planting of forage crops. A report of progress will be made in bulletin form.

BULLETINS.

Nine bulletins were issued during the fiscal year ending June 30, 1903. There is a mass of data, the results of experi-

ments, awaiting preparation. Strenuous effort will be made to have this material prepared in the near future. Popular bulletins will also be prepared on a number of subjects in which much interest is manifested and about which numerous inquiries are received. Respectfully submitted,

J. S. Newman,
Director Agricultural Department.

Report of Chemist.

Clemson College, S. C., September 3, 1903.

President P. H. Mell, Director.

Sir: I respectfully submit the following report of the Chemical Department of the Station for the year ending June 30, 1903.

The work on the *Rotation Experiment*, referred to in previous reports, was completed last year, and the results have this year been published in Bulletin 79.

There have also been published two technical bulletins, one on "The Standardization of Sulphuric Acid," Bulletin 77; the other on "The Nature, Determination and Distribution of the Pentosans in the Sea Island Cotton," Bulletin 78.

These investigations were made and the bulletins prepared by Mr. F. S. Shiver, who is now writing up the results of his study of the *Tea Industry* in South Carolina and is also engaged in a study of the *Tobacco Industry* in this State.

The following work has also been done during the year: Analyses of four samples of rice soils, two samples of sea island cotton soils and two samples of asparagus soils for Col. J. S. Newman, Vice-Director, in charge of the Coast Region Experiments; two samples of rice soils for planters on the Combahee River; five samples of cottonseed meal; one sample of sugar beets and two samples of long-leaved pine ashes for citizens of the State. It is worthy of remark that the *rice soils* were very acid and that they contained in addition to the large quantity of organic acids considerable quantities of soluble sulphates, notably aluminum and iron sulphates, as well as iron sulphide.

The application of lime was recommended in the case of these soils. The soil work was done by Messrs. Shiver and Henry; the other analyses were made partly by these gentlemen and partly by Messrs. McDonnell and Robertson.

STATE ANALYTICAL WORK.

Following is a report of the work on commercial fertilizers, drinking water, minerals, ores, etc., done at the Station under the direction of the Fertilizer Control Committee of the Board of Trustees:

SUMMARY.

	Year ending June 30, 1902.	Year ending June 30, 1903.
Official samples of fertilizers	313	340
Farmers' samples of fertilizers	38	52
Waters	73	70
Limestone and Marls	6	0
Ores and Minerals	18	32
Clays and sands	4	7
Miscellaneous	5	3
Clays from State Geologist	—	20
	457	524

OFFICIAL SAMPLES OF FERTILIZERS.

The number of samples analyzed this year is 340. The analyses are given in full in *Bulletins 80 and 82 of this Station.*

CLASSIFICATION.

	1902.	1903.
Complete fertilizers	141	139
Acid phosphates	45	51
Acid phosphates with potash	51	55
Cottonseed meals	49	69
Kainits	16	15
Nitrate of soda	3	2

	1902.	1903.
Muriate of potash	4	2
Sulphate of potash	1	1
Nitrate of soda with potash	1	1
Ground fish	1	1
Sulphate of ammonia	0	1
Dried blood	0	1
Miscellaneous	1	2
Total	313	340

DEFICIENT SAMPLES.

Of the 340 samples analyzed *23 were deficient under the law.*

In addition to these there were 91 samples which fell below guarantee in one or more constituents, as follows:

In available phosphoric acid	21
In available phosphoric acid and ammonia	2
In available phosphoric acid and potash	3
In potash and ammonia	7
In ammonia	24
In potash	34
Total	91

The extent to which they fell below guarantee is shown in the following table:

	Below Guarantee—Per Cent.				
	.0-.1	.1-.25.	.25-.50.	.50-1.	1 & Over.
In available phosphoric acid	6	7	7	4	1
In ammonia	8	12	12	1	0
In potash	10	17	12	6	0
Total	24	36	31	11	1

The number of samples deficient under the law is much larger than usual, 23 out of 340 opposite 4 out of 313 last year, 12 being the largest number of such deficiencies in any season during the five preceding years.

The number of samples falling below guarantee in one or more constituents, though not deficient in accordance with

law, is also unusually large, there being 91 samples this year opposite 72 last year, 72 being the highest number reached during the last five years. *To the condition of things indicated by this large number of deficiencies, the attention of the Fertilizer Control Committee is respectfully directed.*

AVERAGES OF ANALYSES.

	1902. Per Cent.		1903. Per Cent.	
	Found.	Guaranteed.	Found.	Guaranteed.
ACID PHOSPHATES.				
Soluble phosphoric acid	10.63	.....	9.77	.....
Reverted phosphoric acid	3.48	.....	3.97	.....
Available phosphoric acid	14.11	13.07	13.74	13.23
Insoluble phosphoric acid	1.10	.....	1.17	.....
Total phosphoric acid	15.21	.....	14.91	.....
ACID PHOSPHATES WITH POTASH.				
Soluble phosphoric acid	7.03	.....	6.57	.....
Reverted phosphoric acid	4.06	.....	4.37	.....
Available phosphoric acid	11.09	10.04	10.94	10.17
Insoluble phosphoric acid	1.02	.....	1.26	.....
Total phosphoric acid	12.11	.....	12.20	.....
Potash soluble in water	2.55	2.47	2.65	2.67
COMPLETE FERTILIZERS.				
Soluble phosphoric acid	6.85	.....	6.32	.....
Reverted phosphoric acid	2.54	.....	2.70	.....
Available phosphoric acid	9.39	8.28	9.02	8.26
Insoluble phosphoric acid	1.66	.....	1.42	.....
Total phosphoric acid	11.05	.....	10.43	.....
Ammonia	2.84	2.66	2.69	2.55
Potash soluble in water	2.34	2.10	2.42	2.14
COTTONSEED MEALS.				
Available phosphoric acid	2.57	1.47	2.27	1.47
Ammonia	7.93	7.36	8.08	7.14
Potash soluble in water	1.63	1.00	1.48	1.00
KAINIT.				
Potash soluble in water	12.85	12.00	12.92	12.00
MURIATE OF POTASH.				
Potash (equivalent)	50.54	48.25	50.25	49.00
SULPHATE OF POTASH.				
Potash	49.16	45.00	49.32	50.00
SODIUM NITRATE.				
Ammonia (equivalent)	19.03	18.33	19.15	18.00

The available phosphoric acid and potash in cottonseed meal were guaranteed in only nineteen samples, but these ingredients were determined in all cases.

The following table will prove interesting as showing the yearly averages of fertilizer analyses from the time the Board of Trustees of this College took charge of the Station work down to the present time:

YEARLY AVERAGES OF ANALYSES FROM 1891 TO 1903, INCLUSIVE

Season.	Acid Phosphates.		Acid Phosphates with Potash.			Complete Fertilizers.				Cottonseed Meals.				Kainits.		Muriate of Potash.		Nitrate of Soda.	
	Number of Samples.	Available Phosphoric Acid, Per Cent.	Number of Samples.	Available Phosphoric Acid, Per Cent.	Potash Soluble in Water, Per Cent.	Number of Samples.	Available Phosphoric Acid, Per Cent.	Ammonia, Per Cent.	Potash Soluble in Water, Per Cent.	Number of Samples	Available Phosphoric Acid, Per Cent.	Ammonia, Per Cent.	Potash Soluble in Water, Per Cent.	Number of Samples.	Potash, Per Cent.	Number of Samples.	Potash, Per Cent.	Number of Samples.	Ammonia, Per Cent.
1890-1. . . .	49	13.02	19	11.84	1.65	173	9.34	2.68	1.96	30	.....	8.37	.....	21	12.75	1	51.96	1	19.22
1891-2. . . .	29	12.92	16	11.50	1.49	112	8.83	2.80	1.95	25	.....	8.21	.....	18	12.51	.....	.....	1	18.63
1892-3. . . .	48	12.32	26	11.63	1.22	150	9.00	2.91	1.65	20	2.62	8.40	1.32	20	12.05	.....	.....	.....	.....
1893-4. . . .	46	13.24	22	12.01	1.51	132	9.27	2.53	1.79	22	2.45	8.64	1.69	17	12.37	.....	.....	.....	.....
1894-5. . . .	46	13.55	15	12.09	1.66	87	9.42	2.55	1.77	33	2.58	8.19	1.66	19	12.30	.....	.....	.....	.....
1895-6. . . .	42	13.43	26	11.99	1.39	115	9.31	2.64	1.86	34	2.57	8.45	1.61	16	12.45	.....	.....	.....	.....
1896-7. . . .	59	13.61	34	12.06	1.61	117	9.55	2.70	1.91	40	2.53	8.69	1.64	22	12.44	.....	.....	.....	.....
1897-8. . . .	63	13.67	50	11.54	2.06	141	9.15	2.70	1.93	39	2.37	8.39	1.58	20	12.68	.....	.....	1	19.23
1898-9. . . .	73	13.74	68	11.77	1.99	134	9.32	2.73	2.21	40	2.76	8.25	1.75	14	12.78	2	51.93	2	18.96
1899-1900 . .	73	13.58	63	11.58	2.00	124	9.50	2.73	2.13	52	2.27	8.73	1.63	8	12.73	4	50.95	3	19.01
1900-1. . . .	56	14.00	55	11.49	2.65	139	9.40	2.87	2.47	60	2.38	8.55	1.54	12	12.61	2	48.92	3	18.96
1901-2. . . .	45	14.11	51	11.09	2.55	141	9.39	2.84	2.34	49	2.57	7.93	1.63	16	12.85	4	50.54	3	19.03
1902-3. . . .	51	13.74	55	10.94	2.65	139	9.02	2.69	2.42	69	2.27	8.08	1.48	15	12.92	2	50.25	2	19.15

In this table the ammonia yielded by the nitrogen in fertilizers is given instead of the nitrogen itself, as in the trade goods are still bought and sold on the ammonia basis. The per cent. of nitrogen is easily calculated by remembering that fourteen-seventeenths of the weight of ammonia is nitrogen.

The table shows that during the last few years there has been a general tendency to an increase in the available phosphoric acid in acid phosphates, and a decided increase in the proportion of potash, both in the mixtures of acid phosphates with potash and in complete fertilizers.

GRADES.

In the following table the number of acid phosphates and complete fertilizers of each grade, according to guarantee, is placed side by side with the number found by analysis to belong to that grade, fertilizers having commercial values equal to those of schedule grades being classed in those grades:

	High.		Standard		Low.	
	Claimed.	Found.	Claimed.	Found.	Claimed.	Found.
Complete fertilizers.....(139)	45	54	80	78	14	7
Acid phosphates .....(51)	43	37	8	11	0	3
Acid phosphates with potash.....(55)	25	42	30	9	0	4
Total .....(245)	113	133	118	98	14	14

These results are due to the following changes in grade ascertained by analysis:

	Low to Standard.	Standard to High.	Low to High.	High to Standard.	Standard to Low.	High to Low.	No Change.
Complete fertilizers.....(139)	10	8	1	1	4	0	115
Acid phosphates .....(51)	0	3	0	8	3	1	36
Acid phosphates with potash.....(55)	0	19	0	2	4	0	30
Total .....(245)	10	30	1	11	11	1	181

This shows that out of 245 samples, 181 were of the grade claimed for them, 41 were of a higher grade, and 23 of a lower grade than that claimed for them.

Last year out of 237 samples, 178 were of the grade claimed for them, 55 were of a higher grade, and only 4 of a lower grade than that claimed for them.

FARMERS' SAMPLES OF FERTILIZERS.

In addition to the samples collected by the Official Inspectors, there have been analyzed fifty-two samples for individual farmers. As these analyses cannot be made unless the law and the rules of the Department are complied with, farmers are frequently put to unnecessary trouble and expense through failure to write to the Secretary of the Fertilizer Department for instructions before sending on samples for analysis.

WATER.

Seventy samples have been analyzed. Of these, nine were from deep or artesian wells, five of which were flowing. Of the remaining samples some were sent for sanitary examination, others in the belief that they represented mineral waters of great therapeutic value.

ORES, MINERALS AND OTHER SUBSTANCES.

Forty-two specimens have been assayed or analyzed. Attention is specially called to two of these specimens, which came from the tin ore deposits near Gaffney, S. C. This tin ore, as stated in my last annual report, occurs in a bed of red clay. The specimens of the ore, cassiterite, were separated as far as possible from gangue and submitted to assay. They yielded, respectively, 64 per cent. and 69 per cent. of metallic tin. The ore is free from injurious substances, and if found in large quantities will prove of great value.

ANALYSES FOR STATE GEOLOGIST.

There have been made for the State Geologist complete and rational analyses of twenty samples of clay, involving some 250 separate determinations. These analyses were made as provided for in paragraph 14, Section I, Act of the General Assembly, No. 605, approved February 22, 1902.

DISTRIBUTION OF THE WORK.

The analyses of fertilizers were made by Messrs. McDonnell and Robertson, the analyses of water by Messrs. McDonnell and Henry, the analyses and assays of minerals, ores, etc., by Messrs. Robertson and Henry, and the work for the State Geologist was done by Mr. Robertson. In the office I have had the assistance of Dr. Brackett, who, during my absence on College duty in the summer of 1902, was in charge of all the office work of the labaratory.

It is with pleasure that I renew my acknowledgments of the efficient services which these gentlemen have rendered the Department.

Very respectfully,

M. B. Hardin,
Chief Chemist.

Synopsis of Bulletins.

No. 74, November, 1902. Experiments with Poultry. 6 pages.

No. 75, April, 1903. Cotton Culture. 13 pages.

No. 76, November, 1902. Bermuda Grass. 6 pages.

No. 77, November, 1902. The Standardization of Sulphuric Acid. 7 pages.

No. 78, December, 1902. The Nature, Determination and Distribution of the Pentosans in the Sea Island Cotton. 38 pages.

No. 79, April, 1903. A Rotation Study. 62 pages.

No. 80, April, 1903. Analyses of Commercial Fertilizers. 26 pages.

No. 81, June, 1903. Artificial Incubation of Chickens. 10 pages.

No. 82, June, 1903. Analyses of Commercial Fertilizers. 10 pages.

OF THE
UNIVERSITY OF ILLINOIS
23 APR 1915

SEVENTEENTH ANNUAL REPORT

OF THE

South Carolina Experiment Station,

OF THE

CLEMSON AGRICULTURAL COLLEGE,

FOR THE YEAR ENDING

DECEMBER 31, 1904.

COLUMBIA, S. C.
THE STATE COMPANY, PRINTERS.
1905.

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M. B. Hardin, *Chief Chemist.*
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C. E. Chambliss, M. Sc., *Entomologist.*
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B. H. Rawl, B. S., *Assistant Dairyman and Animal Husbandman.*
F. C. Atkinson, B. S., *Assistant Chemist.*
J. S. Pickett, *Foreman.*
John N. Hook, *Secretary and Librarian.*
Miss Virginia Norris, *Stenographer.*

Mail and telegraph: Clemson College, S. C.

Freight and express: Calhoun, S. C.

The bulletins of the Station are issued at irregular intervals, and are sent free to all citizens of the State who apply for them.

CLEMSON COLLEGE, S. C., December 31, 1904.

Hon. D. C. Heyward, Governor of South Carolina.

Sir: I have the honor to submit herewith the Seventeenth Annual Report of the South Carolina Agricultural Experiment Station, in accordance with the requirements of an Act of Congress approved March 2, 1887, for the Establishment of Agricultural Experiment Stations in connection with the Colleges of the several States, organized under the provisions of an Act approved July 2, 1862.

Respectfully submitted.

P. H. MELL,
President.

THE SOUTH CAROLINA EXPERIMENT STATION IN ACCOUNT WITH THE UNITED STATES APPROPRIATION, 1903-1904.

DR.

To Receipts from the Treasurer of the United States as per appropriation for fiscal year ended June 30, 1904, as per act of Congress approved March 2, 1887 ..... $15,000 00

CR.

	Abstract.		
By Salaries	1		$8,753 88
Labor	2		1,527 56
Publications	3		1,131 33
Postage and stationery	4		102 55
Freight and express	5		153 83
Heat, light, water, and power	6		51 95
Chemical supplies	7		431 22
Seeds, plants, and sundry supplies	8		361 82
Fertilizers	9		142 46
Feeding stuffs	10		1,041 96
Library	11		60 49
Tools, implements, and machinery	12		330 42
Furniture and Fixtures	13		
Scientific apparatus	14		11 00
Live stock	15		
Traveling expenses	16		287 42
Contingent expenses	17		35 63
Buildings and repairs	18		576 48
Balance			
Total			$15,000 00

We, the undersigned, duly appointed Auditors of the Corporation, do hereby certify that we have examined the books and accounts of the Treasurer of South Carolina Experiment Station for the fiscal year ended June 30, 1904; that we have found the same well kept and classified as above, and that the receipts for the year from the Treasurer of the United States are shown to have been $15,000.00, and the corresponding disbursements $15,000.00; for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving no balance.

And we further certify that the expenditures have been solely for the purposes set forth in the act of Congress approved March 2, 1887.

(Signed) R. W. SIMPSON,
M. L. DONALDSON,
Auditors.

[SEAL.]

Attest:

P. H. E. SLOAN,
Custodian.

SOUTH CAROLINA AGRICULTURAL EXPERIMENT STATION, 1903-1904.—SUPPLEMENTARY STATEMENT.

[This supplementary statement, while not required by law, is desired as an aid in interpreting the account rendered for the United States appropriation. While it will be more useful if made in conformity with the schedule fixed for that appropriation, if this is not practicable such a summary of receipts and expenditures from the sources indicated below as can be conveniently prepared from the books of the station may be substituted. Whenever practicable, it should be for the fiscal year ended June 30.]

	State.	Local Community.	Individuals.	Fees.	Farm Products.	Miscellaneous.	Total.
DR.							
To Receipts from other sources than the United States for the year ended.	$....	$....	$....	$....	$....	$....	$3,815 10
CR.							
By Salaries	$....	$....	$....	$....	$....	$....	$803 73
Labor	.....	.....	.....	.....	.....	.....	94 90
Coast Experiments	.....	.....	.....	.....	.....	.....	1,164 20
Registered herd	.....	.....	.....	.....	.....	.....	769 90
Freight and express	.....	.....	.....	.....	.....	.....	.....
Heat, light, water and power	.....	.....	.....	.....	.....	.....	.....
Chemical supplies	.....	.....	.....	.....	.....	.....	.....
Seeds, plants, and sundry supplies	.....	.....	.....	.....	.....	.....	.....
Fertilizers	.....	.....	.....	.....	.....	.....	.....
Feeding stuffs	.....	.....	.....	.....	.....	.....	.....
Library	.....	.....	.....	.....	.....	.....	.....
Tools, implements, and machinery	.....	.....	.....	.....	.....	.....	.....
Furniture and fixtures	.....	.....	.....	.....	.....	.....	.....
Scientific apparatus	.....	.....	.....	.....	.....	.....	.....
Live stock	.....	.....	.....	.....	.....	.....	.....
Traveling expenses	.....	.....	.....	.....	.....	.....	.....
Contingent expenses	.....	.....	.....	.....	.....	.....	.....
Buildings and repairs	.....	.....	.....	.....	.....	.....	.....
Balance	.....	.....	.....	.....	.....	.....	982 27
							$3.815 10

Report of the Vice-Director.

CLEMSON COLLEGE, S. C., October 21, 1904.

Dr. P. H. Mell, Director.

Dear Sir: I have the honor to present herewith material for the annual report of South Carolina Experiment Station for the year ending December 31, 1904. I submit the reports of the chiefs and acting chiefs of divisions, which have been prepared under my general direction.

I take pleasure in stating that efficient work is now being done in all of the divisions. This is materially facilitated by the improved accommodations afforded by the splendid new Agricultural Hall. The presence of the chiefs of divisions in one building renders the administration of the Department of Agriculture very much more satisfactory and effective.

Thanking you for your considerate official cooperation and support in promoting the efficiency of the work of this Department, and in the kindly personal interest which you have manifested in its success.

Very respectfully,

J. S. NEWMAN,
Vice-Director.

REPORT OF THE ASSISTANT AGRICULTURIST.

Prof. J. S. Newman, Vice-Director South Carolina Experiment Station.

Sir: I respectfully submit the following report of the Agricultural Division of the Station for the year ending December 31, 1904:

Wheat, being one of the staple crops of this section, has deservedly received attention on the Station farm for several years past. Believing that the wheat crop has not been as economically fertilized as is consistent with good crops, the ordinary fertilizer test was conducted again this year to aid in getting average results, for a longer period of time, of the different elements of plant food on the crop. In addition, an experiment was conducted with a constant application of phosphoric acid and potash, with variable quantities of nitrogen. A comparative test was conducted as to which is the better mode of planting—in broad, open furrows, or broadcast.

The Durum wheats are being so largely introduced by the United States Department of Agriculture that it was deemed advisable to make a test of the yield of this wheat as compared with one of our best local varieties. The yield of cleaned wheat was much less than that of the local variety. From the result of one year's experiment, we would infer that it would not be a profitable grain crop for this section, but from the hardiness of the plants in withstanding cold, and the comparatively low temperature at which they will grow, it is a promising plant for winter pasture. A test to determine the effect of the three principal elements of the plant food on oats was conducted. Also planting in the broad furrows versus broadcasting.

In the fall of 1903, Edmund Mortimer & Company, of New York, presented the Station with one ton of Peruvian guano, analyzing 3.81 per cent. ammonia, 3.92 per cent. potash, 14.25 per cent. available phosphoric acid, for experimental purposes. This guano was applied at the rate of 500 pounds per acre to oats, wheat, corn, cotton, and sorghum, as compared with an equal amount of plant food furnished by cottonseed meal, acid phosphate, and muriate of potash. Oats and wheat are the only crops that have been harvested to date. It is interesting to note, from one year's experiment, that the Peruvian guano made an increased yield over the Station compound when applied in fall, and that the compounded fertilizer made a slight gain when applied in spring.

Cotton.—For the past five years the work with cotton has been along the line of the improvement of the staple. We now have some crosses that are fairly well established, which possess the prolificness and earliness of the ordinary short staple cotton, and lint practically equal to that of the upland long-staple. This work will be continued in cooperation with the Textile Department. The Agricultural Division will grow the cotton, and do all the field work. The Textile Department will assist in the selection of special stalks, from which to select seed for the next year's planting, and work the lint produced into cloth, noting length of staple, spinning qualities, loss from short fibers, and other points from the manufacturer's standpoint.

Twenty varieties of corn from different States were planted on the Station farm during the past year. This experiment was conducted in cooperation with the Bureau of Plant Industry of the United States Department of Agriculture. The object was to determine the yield of corn from the same variety, when the seed was grown in different States, and to note the change in varietal characters, if any, when grown in this section.

The Willet Drug Company, Augusta, Ga., supplied the Station with Blue Gem watermelon seed, grown in Florida, Georgia, Nebraska, and New Jersey; Florida Favorite, grown in Georgia, Florida, and Nebraska, and Georgia Rattlesnake, grown in Georgia, Florida, and Nebraska, for the purpose of noting any difference in the number, size, and quality of the melons produced from seed grown in the above-mentioned States.

For the past two years the following experiments have been conducted with sorghum as a hay plant: Test of seven varieties, time of planting, amount of seed per acre in drills and broadcast, and fertilizer test.

In the spring of 1903 work, in cooperation with the Chemical Department, was begun with sorghum as a syrup-producing plant. This experiment includes a test of ten of our most common varieties, number of stalks left per acre, time of planting, and the effect of the three principal elements of plant food on the yield of cane-juice and the saccharine content of the juice.

Soil-inoculation experiments were conducted with crimson clover. Inoculating the seed v.s. soil with both local inoculated soils and bacteria prepared by Dr. George F. Moore, Physiologist and Pathologist of the Bureau of Plant Industry, United States Department of Agriculture. Owing to the exceedingly unfavorable winter and spring, crimson clover was a failure this year.

The following hog crops were grown on the Station farm with good results, viz., rape, rye, artichokes, peanuts, chufas, sweet potatoes, cowpeas, and sorghum.

About fifty varieties of cowpeas have been tested this year.

In an effort to get a better sugar cane than sorghum for this section, Japanese sugar cane was secured and tested. The growth has not been satisfactory this year, probably due to the dry autumn.

In 1903 three varieties of truffle oaks were furnished the Station by the Bureau of Plant Industry, United States Department of Agriculture, for the purpose of cooperating later in the development of the famed Truffle in America. *Quercus Ilex* and *Quercus pannonica var pubescens* have all died. *Quercus Robur* is making good growth. By actual measurement, on October 18, 1904, it was found that an extension of twenty inches in length to the upper branches was not an uncommon growth. Dr. David G. Fairchild, Foreign Explorer of the United States Department of Agriculture, recently said that *Quercus Robur* on South Carolina Experiment Station grounds had made better growth than any he had seen in America.

In the spring of 1902 a small area of a badly worn and washed hillside was sown in Black Locust (*Robinia Pseudacacia)* seed. The plants were thinned to about five by eight feet in the spring of 1903, and were cultivated twice a year during the three years of their growth. At the present writing, October 18, 1904, some of the larger trees are about three inches in diameter. The question of supplying posts is getting to be an important item in many sections, and the durability of Black Locust for posts is well known. Growing the plants on the Station grounds was for the purpose of testing the practicability of growing them in this section, and to see if they could be grown on our wasted clay soils.

Preliminary work was begun the past spring, in cooperation with Dr. H. Metcalf, Station Botanist, in the improvement of our common May-pop, with the object in view of making it an economic fruit. Our work has been confined to cultivation and fertilization. So far, marked results have been obtained.

The offspring of three breeds of hogs, viz., Berkshire, Essex, and Poland China, purchased as pigs two years ago, are now sufficient in numbers to begin experiments with the three thoroughbred breeds, and the various crosses obtained. They are

being fed to determine the cost of pork production from each breed and crossbreed.

Respectfully submitted.

H. BENTON,
Assistant Agriculturist.

REPORT OF HORTICULTURIST.

Prof. J. S. Newman, Vice-Director of South Carolina Experiment Station.

Sir: I respectfully submit the following report of the Horticultural Division of the Station for the year ending December 31, 1904.

Apples.—This season forty-five varieties of apples bore fruit, many of which were very fine, and have proven to be well suited to this section of the State. Careful notes have been made on the fruits every year the trees have borne fruit, and notes have also been made as to the condition of the trees from year to year. Some of the varieties have borne fruit regularly every year, while others have a good crop only every other year. Certain varieties have never ripened a crop of fruit, while others planted at the same time (1892) have produced seven crops. The trees were unusually full this year and the apples were smaller than usual. Where the apples were thinned they colored up much better, and were about twice the size of those on the trees that were not thinned.

Spraying experiments to prevent bitter-rot have been conducted for the past five years, and the results show the importance of this work. Seventy per cent. of the Ben Davis apples rotted where the trees were not sprayed, while on the sprayed trees we lost only ten per cent. Eighty-five per cent. of the Kansas Queen apples were destroyed on the unsprayed trees, while we lost only fifteen per cent. on the sprayed trees. Sixty-five per cent. of Carter's Blue rotted on the unsprayed trees, while only fifteen per cent. were destroyed on the sprayed trees. Many of the varieties have shown no signs of the disease at all.

Plums.—Out of the forty varieties of plums, the Wild Goose and Juicy plums were the only ones that produced a full crop.

All of the other varieties were killed by a heavy frost one week after the blooms had dropped. These two varieties are both late bloomers, and for that reason escaped the frost. The trees are in fine condition, and we hope to be able to get notes on these varieties another year.

Grapes.—During the Farmers' Institute we exhibited eighty-four varieties of grapes, all of which were in good condition. This exhibit attracted a great deal of attention, and, judging from the increased number of inquiries received, more interest is being taken in grapes, both for home and market, than ever before.

Notes have been taken on these varieties from the date of blooming to the ripening of the fruit. Marked results have been obtained from bagging these varieties. Some varieties that ripened in August have been kept in good condition in bags until the fifteenth of October, while others would only keep a few days after maturing. Many of these varieties, subject to disease, cannot be grown to perfection unless they are sprayed, while others have been free from disease. Five varieties of European grapes fruited this year, and all but one were kept free from disease by spraying. These grapes have stood three winters without any protection, and I believe they can be grown profitably in this State, if they receive the proper care and attention.

The habit of growth of the many varieties tested varies greatly, and the method of pruning one variety will not apply to all. Certain varieties have given best results when severely pruned, while others have done best when rather long canes were left. A study of the best methods of pruning the varieties best suited to our State will be made. Many of these new varieties of grapes have only fruited one season, and for that reason the test is not yet complete. They will have to be grown several years with success before they can be recommended.

Peaches.—The old peach orchard is fast failing, and, as many of the varieties have proven to be of no value, a good many of the trees have been taken up, and a young orchard set out. This young orchard should bear its first fruit next year. There are a great many varieties of peaches that have been introduced in the last few years, that have not yet been

tested here, as we had no place to plant them. These varieties will, however, be planted this fall. We have secured cions of several valuable varieties of peaches that have not been introduced. We are growing a few trees of these new varieties in order to have them tested in various parts of the State.

Pecans.—Sixty of our seedling pecans bore fruit last season, and only four trees produced nuts of good size. The largest nuts would average sixty-four to the pound, while it would require as many as one hundred and ninety-two to make a pound from other trees. Many seedlings are being planted in this State, and the growers will be greatly disappointed after a number of years to find that the nuts will not be half the size of those they planted. The best varieties now being planted will average from thirty to thirty-five nuts to the pound.

Celery.—We have twenty varieties of celery this year, but on account of the severe drouth we have had during September and October, the plants are not growing as they should. We have been testing these varieties for the last three years, and are now ready to publish the results of our test. We have also tested various methods of blanching celery.

Irish Potatoes.—The following experiments with Irish potatoes have been under way for the last three years:

1. Variety test (twenty-nine varieties).
2. Methods of planting for fall crop.
3. Southern- and Northern-grown seed planted for comparison.
4. Fall and spring planting compared.
5. Experiments in keeping both spring and fall crop.

Variety tests have been made of the following vegetables in addition to those mentioned above: Tomatoes, beets, lettuce, onions, cabbage, cantaloupes, eggplant, cucumbers, spinach, and salsify.

Raspberries and Blackberries.—We are testing a large number of raspberries and blackberries, and after another year's test we will be ready to publish our results.

New varieties of various fruits and vegetables are being introduced every year. We test all these varieties, as far as

possible, so as to be able to advise those making inquiry about them, as to their merits.

I have been greatly assisted in the work of this Division by the efficient services rendered by Mr. Burns Gillison.

Very respectfully,

C. C. NEWMAN,

Horticulturist.

October 21, 1904.

REPORT OF ASSISTANT VETERINARIAN.

Col. J. S. Newman, Vice-Director of South Carolina Experiment Station.

Dear Sir: As per your request, I am submitting a report to you, with reference to experiments, contemplated or in progress, for the year ending December 31, 1904.

First, though, I desire to call your attention to the fact that I am not a member of the Experiment Station staff, which necessarily places me in a very embarrassing position as to stating what the Veterinary Division will do, further than to try to carry out the plans, as I know them, of Dr. G. E. Nesom, whose successor has not been appointed.*

At present, the only experiment in progress is keeping in touch with the two hundred head of cattle, which were inoculated last winter. No conclusion can be derived from, or report made on, this till it is learned whether or not these cattle were rendered immune to Texas Fever, and lived through at least one season of infection. I earnestly hope to see this inoculation of cattle continue, under the supervision of this Station, when it is desired by the cattle owners of the State, so long as they pay the expense of feeding, care, etc., of cattle while undergoing the inoculation.

The work concerning the treatment and prevention of Milk Fever *(Parturient Paresis)* is still in progress, though this is

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*Dr. Louis A. Klein was appointed Veterinarian October 1st, but did not report for duty until after this report was written.

much delayed owing to the fact that subjects for experiments along this line can only be had as they occur in the College herd, or as the Veterinarian is permitted to see them in the vicinity of the College.

The investigation, as planned, concerning internal parasites affecting sheep will have to be abandoned, owing to the revoking of the appropriation for fencing in inclosures, small barn, etc., by recent act of the Board. This, however, is a subject which I hope to see receive its just consideration in the near future, as it means a great deal to the sheep owners of this State.

At present considerable inquiries concerning a disease in chickens are received by the Veterinary Division. From the reports received, this disease must be somewhat general, and, as there is a great similarity in the reports, I am forced to the conclusion that some systematic and thorough investigation should be adopted whereby the poultry owners of the State could be informed, through a bulletin, of the nature and treatment of this disease. But at present there are no funds available for such investigation.

Also, there is a disease, resembling sore mouth *(Pustula Stomatitis)*, among the dogs of the State, which seems to be contagious, and which, if investigated thoroughly, would be of great benefit to the different kennels throughout the State, as well as to owners of wellbred individuals. Plans as to collecting data concerning this disease, as well as the one existing in poultry, were discussed with Dr. Nesom before his resignation. It was agreed to devote as much time as possible to the subject, though since his resignation my time has been so occupied that it has been impossible to pursue the matter with the system which I had hoped it would receive, although I am still making, as opportunity presents, investigations along this line.

At a recent interview with the assistant in charge of the Animal Husbandry Division, my cooperation was solicited in connection with an experiment proposed in that Division, testing the ill effects of cottonseed meal, if any, as a foodstuff. I heartily acquiesced with the plans of this experiment, and as soon as it can be put into execution, I hope this Division will

be able to contribute to its interest, as well as value, by noting from time to time the physiological condition of animals used as subjects in this experiment.

Respectfully submitted.

A. S. Shealy,
Assistant State Veterinarian.

October 17, 1904.

Report of Botanist and Bacteriologist.

Prof. J. S. Newman, Vice-Director of South Carolina Experiment Station.

Dear Sir: I beg to submit the following report:

Correspondence.—The correspondence of this Division has perceptibly increased since the last report. This increase has consisted of letters from teachers in public schools, asking for advice on matters pertaining to Nature Study teaching; and letters from persons interested in their own sanitary surroundings, especially with reference to the matters discussed, and methods advocated, in Bulletin No. 89. It is gratifying to note that my recommendation in an earlier report that Nature Study bulletins be issued, for the use of the teachers in the State, has been favorably acted upon, and that the College will shortly issue a series of such bulletins. This ought to materially decrease the correspondence of this Division, as it will supply much of the information which the teachers now seek through correspondence.

Library.—The library of this Division is still inadequate. As I have previously pointed out, considerable delay in answering correspondence arises from the fact that books for the identification of plants have to be borrowed from other institutions, or from the National Department of Agriculture, before letters can be answered. In my next financial report I shall recommend a small special appropriation to meet this need.

Herbarium.—The number of specimens in the herbarium has been further augmented by collections of economic plants, and of plant diseases. During the ensuing year, the herbarium work will have to largely come to a standstill, as no money is

available for student labor, upon which the work of the herbarium largely depends.

Investigations.—Observations on sanitary conditions of the State have continued, and a bulletin on the subject has been issued. The bulk of my time has, however, been given up to the study of the rice blast. During the winter months I have given all my time to the laboratory study of the fungi associated with the disease. Fertilizer experiments have been undertaken on two plantations on the Cooper River, and one on the Combahee. Since May 1st this work has been in collaboration with the Division of Vegetable Physiology and Pathology of the United States Department of Agriculture. I may add that since June 30th I have been able to put in two months in the fields, and have not only determined to a high degree of probability the cause of the rice blast, but also have found what appears to be a practical method of preventing the disease, at least in those localities where the land is rested. During the coming year this work will be continued, and I shall devote my entire time to it, to the exclusion, if necessary, of the other lines of investigation mentioned in previous reports; as this disease, according to the reports of the planters, has caused a loss in this State of over $1,000,000.00 in the past six years, and is threatening the entire industry. It is very gratifying to realize that in this work I shall have the use of a greenhouse, the need of which I have mentioned in several previous reports.

Respectfully submitted.

Haven Metcalf,
Botanist and Bacteriologist.

Report of Entomologist.

Prof. J. S. Newman, Vice-Director of South Carolina Experiment Station.

Dear Sir: Since my last report I have had the following insects under observation: woolly aphis, peach borer, harlequin cabbage bug, San Jose scale, plum curculio, codling moth, several species of plant lice, sheep tick, cattle lice, boll worm,

cotton caterpillar, cowpea pod weevil, and red spider. I have also made an effort to secure a cheap, effective, and easily applied insecticide for the peach borer, San Jose scale, sheep tick, and cattle lice, and in several parts of the State I have directed experiments to determine the amount of paris green that may be safely used on peach foliage. Although this work is to be continued, I suggest the publication, in bulletin form, of the notes that have accumulated during the season, as they contain data of value to the farmers of the State.

During August and September, in collaboration with the Bureau of Entomology, United States Department of Agriculture, I gave my time to the study of the insects of rice. I gave particular attention to the water weevil, the rice stalk borer, and the sucking insects affecting the rice heads. The latter was for the purpose of determining to what extent, if any at all, these insects act as agents in the distribution of the disease commonly known as "rotton neck." This work will be placed upon an experimental basis next year, to establish definitely what part insects play in the distribution of this disease.

In the rotation and soil management experiments, proposed by the Agricultural Division of the Station, I will keep accurate record of the insects affecting the plants employed in the experiments. I shall also note the effect of rotation and soil manipulation upon the insects affecting these plants, especially those that are injurious to subterranean parts.

To prepare myself for an emergency that might arise from the escape of the living cotton boll weevils that had been brought into the State through curiosity by many of our farmers, I spent July in Texas, in association with Prof. W. D. Hunter and his corps, studying the habits of this insect and the methods now employed for its control. Upon my return home the large quantity of material, including photographs, which I had collected for illustrating the life history of the cotton boll weevil, was prepared for exhibition and sent to the newspapers of the State. These collections were placed in conspicuous places, and were well advertised by the newspapers that had received them. Many expressions of appreciation for this work have been received, and by request I am now preparing a

bulletin, with illustrations, in which the government work on this insect will be reviewed.

I am still collecting data on cotton insects, with a view of publishing, in the near future, a bulletin containing the life history of these insects, as well as a discussion of the methods used for their control.

Respectfully submitted.

Charles E. Chambliss,
Entomologist.

October 10, 1904.

Report of Acting Chief of Division of Animal Husbandry and Dairying.

Col. J. S. Newman, Vice-Director of South Carolina Experiment Station.

Dear Sir: Please allow me to submit the following report of the Division of Animal Husbandry and Dairying for the year ending December 31, 1904.

During the months of March and April, 1904, an experiment was conducted to determine the comparative cost of butter produced by Ayrshire and Jersey cows. The test is to be repeated next winter, and Shorthorns and Devons are to be included. When the work has been carried on long enough to enable us to draw conclusions, the total result will be published.

Last spring the Divisions of Entomology and Animal Husbandry did some cooperative work on animal parasites, the object being to determine the most practical methods and substances for farmers to use to remove external parasites. This work will be continued, and results published as soon as possible.

An experiment is now in progress to determine the cost of beef produced by grade Holstein and grade Angus. It is the object of this Division to continue this work, and include in the test the grades of other breeds, as soon as we can get them.

The following experimental work has been planned for the ensuing year:

First. To test the comparative grazing quality of Durum wheat and rye in winter, to determine which will produce the greater quantity and the superior quality at this season.

Second. To begin an experiment to determine, if possible, what injurious effects are produced, if any, by heavy and continuous feeding of cottonseed meal to milch cows. It is desirable to have the cooperation of the Veterinary Division in this work.

Third. To test the comparative feeding value in winter, the keeping quality and the cost of production of each of the following root crops: Sweet potatoes, sugar beets, carrots, and mangel wurtzels. The object of this work is to determine the value of these crops compared with silage for winter feed for cattle, with a view to showing to what extent the small farmer can substitute these crops for silage. The cooperation of the Division of Agriculture is solicited in this work.

Fourth. To again cooperate with the Division of Agriculture in determining the comparative cost of production and feeding value of the following crops: Rye, barley, vetch, oats, and crimson clover, for winter; and pearl millet, German millet, cowpeas, sorghum, teosinte, and corn for summer.

Fifth. To conduct an experiment to determine the cost of production of winter lambs from scrub ewes and pure-bred rams.

Sixth. To cooperate with the Veterinary Division in cleaning the farm of ticks.

Facilities are not yet available for carrying on all of the above named work, but it is our earnest hope that they will be supplied in time for us to begin all of this work during the coming winter and spring.

It is the policy of this Division to increase the amount of experimental work just as rapidly as possible, though at present this work is, to some extent, handicapped on account of limited amount of stock. But the herd and flock are rapidly increasing, and we hope very soon to be able to overcome this difficulty.

We hope, also, very soon to be allowed to begin experimental work with hogs in this Division, for this work, of course, should be included in the Division of Animal Husbandry.

Respectfully submitted.

B. H. Rawl,
Acting Chief of Division.

October 17, 1904.

Report of Chemist.

Clemson College, S. C., December 27, 1904.

President P. H. Mell, Director.

Sir: I respectfully submit the following report of the Chemical Department of the Station, for the year ending June 30, 1904.

In my last annual report reference was made to the analysis of certain samples of *rice soils* received from Col. J. S. Newman, Vice-Director of the Agricultural Department of the Station, in charge of the Coast Region experiments. It was stated that the soils were found to be very acid, and to contain not only a large quantity of organic acid, but also considerable quantities of aluminium and iron sulphates, and some iron sulphide. It was suggested that lime might prove beneficial to these soils, and the Agricultural Department of the Station undertook a series of pot experiments with one of the soils, using lime at the rate of from 1,800 pounds to 18,000 pounds per acre, the last proportion corresponding with the results obtained in the laboratory by the ammonia test for determining soil acidity. The results of the pot experiments are given in Bulletin 91 of this Station, in the report of Colonel Newman. It appears that, as far as the experiments went, the largest application of lime seemed beneficial. Further tests with lime have been made this year in plot experiments on rice lands, by Dr. Metcalf, the Botanist of the Station, whose reports for this year, and following ones, are looked forward to with much interest. Other work in progress consists in experiments on *sorghum* in cooperation with the Agricultural Department of

the Station. This is a continuation of the investigation begun last year, one bulletin on the subject having been already published. The work is being done by Mr. F. S. Shiver, who reports also that he has completed the investigation of the *Tea Industry* of South Carolina, and nearly finished a study of the *Tobacco Industry* in this State. The results of these investigations will be presented for publication in bulletin form as soon as the manuscripts are ready.

In addition to the foregoing, the following analyses have been made:

1 sample of joint grass for Col. J. S. Newman.
1 sample of soil for Mr. J. G. Murray, Edisto Island, S. C.
2 samples of rice meal for Mr. Thomas Taylor, Jr., Columbia, S. C.
1 sample of cow manure for Mr. Thomas Taylor, Jr., Columbia, S. C.

ANALYSIS OF COMMERCIAL FERTILIZERS.

Following is a report of the work on commercial fertilizers, done under the direction of the Fertilizer Control Committee of the Board of Trustees:

	Season 1902-03.	Season 1903-04.
Official samples	340	402
Farmers' samples	52	125
	392	527

OFFICIAL SAMPLES OF FERTILIZERS.

The number of samples analyzed this year is 402. The analyses are given in full in *Bulletins 87 and 92 of this Station.*

CLASSIFICATION.

	1903.	1904.
Complete fertilizers	139	180
Acid phosphates	51	59
Acid phosphates with potash	55	75
Cottonseed meals	69	57

	1903.	1904.
Kainits	15	11
Nitrate of soda	2	6
Muriate of potash	2	7
Sulphate of potash	1	2
Nitrate of soda with potash	1	0
Ground fish	1	2
Sulphate of ammonia	1	1
Tankage	0	1
Dried blood	1	0
Miscellaneous	2	1
Totals	340	402

DEFICIENT SAMPLES.

Of the 402 samples analyzed, 18 were deficient under the law. In addition to these there were 124 samples which fell below the guarantee in one or more constituents, as follows:

In available phosphoric acid	21
In available phosphoric acid and potash	5
In potash and ammonia	16
In ammonia	40
In potash	42
Total	124

The extent to which they fell below guarantee is shown in the following table:

	Below Guarantee—Per Cent.				
	.0-.10	.10-.25	.25-.50.	.50-1.00	1.00 and Over
In available phosphoric acid	3	13	7	3	0
In ammonia	15	24	14	2	1
In potash	6	28	17	6	6
Total	24	65	38	11	7

The number of samples deficient under the law is smaller this season than last, 18 out of 402, opposite 23 out of 340, or 4.48 per cent. opposite 6.76 per cent.

The number of samples falling below guarantee in one or more constituents, though not deficient in accordance with law, is larger this season than last, there being 124 out of 402 opposite 91 out of 340, or 30.85 per cent. opposite 26.76 per cent.

AVERAGES OF ANALYSES.

	1903. Per Cent.		1904. Per Cent.	
	Found.	Guaranteed.	Found.	Guaranteed.
ACID PHOSPHATES.				
Soluble phosphoric acid	9.77	.....	11.09	.....
Reverted phosphoric acid	3.97	.....	3.23	.....
Available phosphoric acid	13.74	13.23	14.32	13.61
Insoluble phosphoric acid	1.17	.....	.78	.....
Total phosphoric acid	14.91	.....	15.10	.....
ACID PHOSPHATES WITH POTASH.				
Soluble phosphoric acid	6.57	.....	7.33	.....
Reverted phosphoric acid	4.37	.....	3.79	.....
Available phosphoric acid	10.94	10.17	11.12	10.13
Insoluble phosphoric acid	1.26	.....	.82	.....
Total phosphoric acid	12.20	.....	11.94	.....
Potash soluble in water	2.65	2.67	2.81	2.71
COMPLETE FERTILIZERS.				
Soluble phosphoric acid	6.32	.....	6.16	.....
Reverted phosphoric acid	2.70	.....	2.96	.....
Available phosphoric acid	9.02	8.26	9.12	8.27
Insoluble phosphoric acid	1.42	.....	1.50	.....
Total phosphoric acid	10.44	.....	10.62	.....
Ammonia	2.69	2.55	2.99	2.93
Potash soluble in water	2.42	2.14	2.90	2.71
COTTONSEED MEALS.				
Available phosphoric acid	2.27	1.47	2.28	1.54
Ammonia	8.08	7.14	7.92	7.06
Potash soluble in water	1.48	1.00	1.54	1.21
KAINITS.				
Potash soluble in water	12.92	12.00	12.94	12.00
MURIATE OF POTASH.				
Potash soluble in water	50.25	49.00	49.79	49.72
SULPHATE OF POTASH.				
Potash soluble in water	49.32	50.00	53.47	.....
NITRATE OF SODA.				
Ammonia (equivalent)	19.15	18.00	18.87	18.00

The available phosphoric acid and potash in cottonseed meals were guaranteed in only twelve samples, but these ingredients were determined in all cases.

The following table shows the yearly averages of fertilizer analyses from the time the Board of Trustees of this College took charge of the Station work down to the present time:

YEARLY AVERAGES OF ANALYSES FROM 1891 TO 1904, INCLUSIVE.

Season.	Acid Phosphates.		Acid Phosphates with Potash.			Complete Fertilizers.				Cottonseed Meals.				Kainits.		Muriate of Potash.		Nitrate of Soda.	
	Number of Samples.	Available Phosphoric Acid, Per Cent.	Number of Samples.	Available Phosphoric Acid, Per Cent.	Potash Soluble in Water, Per Cent.	Number of Samples.	Available Phosphoric Acid, Per Cent.	Ammonia, Per Cent.	Potash Soluble in Water, Per Cent.	Number of Samples	Available Phosphoric Acid, Per Cent.	Ammonia, Per Cent.	Potash Soluble in Water, Per Cent.	Number of Samples.	Potash, Per Cent.	Number of Samples.	Potash, Per Cent.	Number of Samples.	Ammonia, Per Cent.
1890-1. . . .	49	13.02	19	11.84	1.65	173	9.34	2.68	1.96	30	.....	8.37	.....	21	12.75	1	51.96	1	19.22
1891-2. . . .	29	12.92	16	11.50	1.49	112	8.83	2.80	1.95	25	.....	8.21	.....	18	12.51	.....	.....	1	18.63
1892-3. . . .	48	12.32	26	11.63	1.22	150	9.00	2.91	1.65	20	2.62	8.40	1.32	20	12.05	.....	.....	.....	.....
1893-4. . . .	46	13.24	22	12.01	1.51	132	9.27	2.53	1.79	22	2.45	8.64	1.69	17	12.37	.....	.....	.....	.....
1894-5. . . .	46	13.55	15	12.09	1.66	87	9.42	2.55	1.77	33	2.58	8.19	1.66	19	12.30	.....	.....	.....	.....
1895-6. . . .	42	13.43	26	11.99	1.39	115	9.31	2.64	1.86	34	2.57	8.45	1.61	16	12.45	.....	.....	.....	.....
1896-7. . . .	59	13.61	34	12.06	1.61	117	9.55	2.70	1.91	40	2.53	8.69	1.64	22	12.44	.....	.....	.....	.....
1897-8. . . .	63	13.67	50	11.54	2.06	141	9.15	2.70	1.93	39	2.37	8.39	1.58	20	12.68	.....	.....	1	19.23
1898-9. . . .	73	13.74	68	11.77	1.99	134	9.32	2.73	2.21	40	2.76	8.25	1.75	14	12.78	2	51.93	2	18.96
1899-1900 . .	73	13.58	63	11.58	2.00	124	9.50	2.73	2.13	52	2.27	8.73	1.63	8	12.73	4	50.95	3	19.01
1900-1. . . .	56	14.00	55	11.49	2.65	139	9.40	2.87	2.47	60	2.38	8.55	1.54	12	12.61	2	48.92	3	18.96
1901-2. . . .	45	14.11	51	11.09	2.55	141	9.39	2.84	2.34	49	2.57	7.93	1.63	16	12.85	4	50.54	3	19.03
1902-3. . . .	51	13.74	55	10.94	2.65	139	9.02	2.69	2.42	69	2.27	8.08	1.48	15	12.92	2	50.25	2	19.15
1903-4. . . .	59	14.32	75	11.12	2.81	180	9.12	2.99	2.90	57	2.28	7.92	1.54	11	12.94	7	49.79	6	18.87

In this table the ammonia yielded by the nitrogen in fertilizers is given instead of the nitrogen itself, as in the trade goods are still bought and sold on the ammonia basis. The per cent. of nitrogen is easily calculated, as fourteen-seventeenths of the weight of ammonia is the weight of the nitrogen it contains.

The table shows that there is a continued tendency towards the production of higher-grade goods in the case of acid phosphates and mixed fertilizers, the increase in the percentage of potash being especially noticeable. This is doubtless due to the demands of farmers who are beginning to realize that it is poor economy to purchase low-grade materials.

There has been in general no improvement in the grade of cottonseed meals, the average per cent. of ammonia yielded by the meals being a little lower even than it was during the last two seasons.

GRADES.

In the following table the number of acid phosphates, acid phosphates with potash, and complete fertilizers of each grade, according to guarantee, is placed side by side with the number found by analysis to belong to that grade, fertilizers having commercial values equal to those of schedule grades being classed in those grades:

	High.		Standard.		Low.	
	Claimed.	Found.	Claimed.	Found.	Claimed.	Found.
Complete fertilizers..(180)	83	89	88	86	9	5
Acid phosphates .....(59)	56	56	3	3	0	0
Acid phosphates with potash .....(75)	30	59	45	12	0	4
Total .....(314)	169	204	136	101	9	9

These results are due to the following changes in grades ascertained by analysis:

	Low to Standard.	Standard to High.	Low to High.	High to Standard.	Standard to Low.	High to Low.	No Change.
Complete fertilizers.....(180)	7	9	0	3	3	0	158
Acid phosphates.....(59)	0	3	0	3	0	0	53
Acid phosphates with potash .....(75)	0	25	0	1	4	0	45
Total .....(314)	7	37	0	7	7	0	256

This shows that out of 314 samples, 256 were of the grade claimed for them, 44 were of a higher grade and 14 of a lower grade than that claimed for them.

Last year out of 245 samples, 181 were of the grade claimed for them, 41 were of a higher grade, and 23 of a lower grade than that claimed for them.

FARMERS' SAMPLES OF FERTILIZERS.

In addition to the samples of fertilizers collected by the Official Inspectors, there have been analyzed 125 samples for individual farmers.

WATER.

Fifty-nine samples have been analyzed. Most of them were sent for sanitary examination.

DISTRIBUTION OF THE WORK.

Fertilizers were analyzed by Messrs. C. C. McDonnell and B. F. Robertson; waters by Messrs. McDonnell and D. H. Henry. Dr. R. N. Brackett has aided me in office duties.

Very respectfully,

M. B. HARDIN,
Chief Chemist.

Synopsis of Bulletins.

No. 83, March, 1904. Results of Practical Experiments with Peach Borer. 9 pages.

No. 84, April, 1904. Popular Bulletin, One Horse Farm. 6 pages.

No. 85, April, 1904. Commercial Fertilizers. (1) Summary of Analyses for 1902-1903. (2) Comparison with Results of Previous Years. (3) Remarks on Cottonseed Meal.

No. 86, May, 1904. Tobacco Culture in South Carolina.

No. 87, April, 1904. Analyses of Commercial Fertilizers.

No. 88, May, 1904. Sorghum as a Syrup Plant.

No. 89, May, 1904. Popular Bulletin, Sanitary Conditions in the Home and on the Farm.

OF THE
UNIVERSITY OF ILLINOIS
APR 1915

EIGHTEENTH ANNUAL REPORT

OF THE

South Carolina Experiment Station,

OF THE

CLEMSON AGRICULTURAL COLLEGE,

FOR THE YEAR ENDING

JUNE 30, 1905.

COLUMBIA, S. C.
THE STATE CO., PRINTERS.
1906.

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The bulletins of the Station are issued at irregular intervals, and are sent free to all citizens of the State who apply for them.

CLEMSON COLLEGE, S. C., December 31, 1905.

Hon. D. C. Heyward, Governor of South Carolina.

Sir: I have the honor to submit herewith the Eighteenth Annual Report of the South Carolina Agricultural Experiment Station, in accordance with the requirements of an Act of Congress approved March 2, 1887, for the Establishment of Agricultural Experiment Stations in connection with the Colleges of the several States, organized under the provisions of an Act approved July 2, 1862.

Respectfully submitted,

P. H. MELL,
President.

THE SOUTH CAROLINA EXPERIMENT STATION IN ACCOUNT WITH THE UNITED STATES APPROPRIATION, 1904-1905.

Dr.

To Receipts from the Treasurer of the United States as per appropriation for fiscal year ended June 30, 1905, as per act of Congress approved March 2, 1887	$15,000 00

Cr.

By Salaries	$ 9,878 92
Labor	1,423 58
Publications	1,560 02
Postage and stationery	105 28
Freight and express	75 99
Heat, light, water, and power	122 75
Chemical supplies	483 12
Seeds, plants, and sundry supplies	261 65
Fertilizers	490 90
Feeding stuffs	.....
Library	59 12
Tools, implements, and machinery	14 32
Furniture and fixtures	21 86
Scientific apparatus	3 55
Live stock	38 09
Traveling expenses	379 65
Contingent expenses	31 20
Buildings and repairs	.....
Balance	.....
Total	$15,000 00

We, the undersigned, duly appointed Auditors of the Corporation, do hereby certify that we have examined the books and accounts of the Clemson Agricultural College for the fiscal year ended June 30, 1905; that we have found the same well kept and classified as above, and that the receipts for the year from the Treasurer of the United States are shown to have been $15,000.00, and the corresponding disbursements $15,000.00; for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving no balance.

And we further certify that the expenditures have been solely for the purposes set forth in the act of Congress approved March 2, 1887.

(Signed) R. W. SIMPSON,
Chairman Committee.

[SEAL.]
Attest:

P. H. E. SLOAN,
Custodian.

ABSTRACT—SALARIES.

Director and administrative officers	No. 4	Amount	$3,299 92
Scientific staff	No. 9	Amount	5,479 08
Assistants to scientific staff	No. 3	Amount	1,099 92
Special and temporary services			.....
Total			$9,878 92

ABSTRACT—PUBLICATIONS.

For printing 25 Bulletins—No. of pages 391. Total edition 300,000)	$1,501 75
For printing Annual Report—No. of pages 26. (Total edition 1,000)	40 50
For envelopes for bulletins and reports	17 77
Other expenses	.....
Total	$1,560 02

ABSTRACT—SEEDS, PLANTS, AND SUNDRY SUPPLIES.

Agricultural	$ 88 00
Horticultural	114 96
Botanical	31 47
Entomological	.....
Miscellaneous	27 22
Total	$ 261 65

ABSTRACT—CONTINGENT EXPENSES.

College and Experiment stations	$ 15 00
Keys	94
Nose rings	1 25
Stationery	3 53
Calf feeders	5 08
W. C. paper	5 40
Total	$ 31 20

SOUTH CAROLINA AGRICULTURAL EXPERIMENT STATION, 1904-1905.—SUPPLEMENTARY STATEMENT.

[This supplementary statement, while not required by law, is desired as an aid in interpreting the account rendered for the United States appropriation.]

	State.	Local Community.	Individuals.	Fees.	Farm Products.	Miscellaneous.	Total.
Dr.							
Balance.	.....	.....	.....	.....	.....	.....	$ 982.27
To Receipts from other sources than the United States for the year ended . .	$1,620.83	$....	$....	$....	$960.70	$1,653.07	4,234.60
							$5,216.87
Cr.							
Labor	$.....	$....	$....	$....	$.....	$.....	$ 173.15
Registered herd .	.....	.....	.....	.....	.....	.....	1,653.07
Publications . . .	.....	.....	.....	.....	.....	.....	340.75
Coast Experiments..	.....	.....	.....	.....	.....	.....	1,620.83
Freight and express.	.....	.....	.....	.....	.....	.....	49.88
Heat, light, water and power . . .	.....	.....	.....	.....	.....	.....	23.94
Seeds, plants and sundry supplies	.....	.....	.....	.....	.....	.....	18.32
Fertilizers	.....	.....	.....	.....	.....	.....	67.50
Tools, implements and machinery.	.....	.....	.....	.....	.....	.....	22.50
Furniture and fixtures	.....	.....	.....	.....	.....	.....	35.78
Balance.	.....	.....	.....	.....	.....	.....	1,211.15
							$5,216.87

Report of the Director.

CLEMSON COLLEGE, S. C., Dec. 8, 1905.

Dr. P. H. Mell, President, Clemson College, S. C.

Dear Sir: I have the honor to submit herewith the reports of the chiefs of divisions of this Experiment Station, forming the material for the Annual Report of the South Carolina Experiment Station for the year ending June 30, 1905.

This is the report of the work done under the general supervision of my predecessor, Col. J. S. Newman. After his retirement it was with pleasure that I assumed the duties and responsibilities of an office once filled by so distinguished and beloved a man, and I am happy to find myself associated with a corps of enthusiastic and efficient scientists and educators.

It is my belief that our Experiment Station is destined to be a potent factor in the future development of the material welfare of our state and nation.

Our policy shall be to develop this work in a most conservative way, and along the lines that will be of the greatest practical value to our farmers, stockmen, and horticulturists. While there are yet probably many undiscovered facts relating to science and agriculture, we shall not endeavor to discover all of these at one time, but by thoroughly executing carefully planned experiments, we hope to obtain data which will be of value as long as this commonwealth shall exist.

We do not intend to spend all of our energies in the pursuance of original research work. It is our intention not only to do needed original research work, but actively to disseminate truths already discovered, though not spread among the people, so that the great mass of farmers may be directly and immediately benefited. This we will do by college extension work, farmers' institutes, and popular bulletins.

I take this opportunity to expresss to you my great appreciation of the many valuable suggestions you have given us and of the personal and official interest you have shown in this work.

I am, sir, Yours most respectfully,

(Signed) J. N. HARPER,
Director.

Report of the Associate Agriculturist.

Clemson College, S. C., Nov. 28, 1905.

Prof. J. N. Harper, Director, S. C. Experiment Station, Clemson College, S. C.

Dear Sir: In accordance with your instruction, I am submitting the following report for the Agricultural Division of the South Carolina Experiment Station for the year ending June 30, 1905:

When I entered upon my duties on June 20, 1905, I inspected the work under way in company with the former Director of the Agricultural Department, and found experiments being carried on with the following: Wheat, oats, beardless barley, corn, cotton, cowpeas, alfalfa, hairy vetch, Soy beans, velvet beans, Newman beans, sweet potatoes, truffle oats, black locust, May-pops and fertilizers.

The object of these experiments briefly stated, was:

Wheat: Variety, fertilizer and cultural tests.

Oats: Variety, fertilizer and cultural tests and a comparison of yields from same varieties, the seed of which were procured from several States.

Beardless Barley: To test its adaptability.

Corn: Variety test conducted in cooperation with the United States Department of Agriculture.

Cotton: Variety test, test of new varieties produced by cross breeding and selection, and fertilizer test. Some sixty-odd varieties were prepared for exhibition on Farmers' Institute car.

Cowpeas: Variety test with a large number of established varieties and new cross-bred productions, the development of strains particularly suited to hay or grain production, and for fertilizing purposes. Forty-odd varieties and strains of these were exhibited on Farmers' Institute car.

Alfalfa: Cultural and inoculation tests.

Hairy Vetch: Cultural, inoculation and soil improvement tests and for hay.

Soy Beans: Soil improvement, hay and grain tests.

Velvet Beans: Soil improvement and cover crop.

Newman Bean: Soil improvement and cover crop.

Sweet Potato: For starch production.

Truffle Oats: For production of truffles.

Black Locust: For growing posts on worn soils.

Maypops: For developing economic value.

Fertilizer Tests: For determining best fertilizers and combinations of fertilizers for different crops; for recuperation of impoverished soils and for their more economic use by utilizing legumes as a source of nitrogen.

Since June 20, 1905, the following experimental work has been undertaken:

Wheat: Twenty-odd varieties planted for variety tests.

Oats: Eight or ten varieties planted for variety test.

Cowpeas: Eighty-odd varieties, crosses and selections planted to determine varieties best suited for grain, hay, soil improvement, cover crop; quantity of seed per acre of different varieties giving best returns and development of new strain suited to special purposes, such as for hay and grain production, uniformity of ripening, green manuring, cover crop and for growing with corn.

Alfalfa: To demonstrate the practicability of making this a profitable hay crop and to test the value of inoculation with nitrogen gathering bacteria.

Crimson Clover: As a winter cover and soil improvement crop, for grazing and for hay.

Hairy Vetch: As a winter cover and soil improvement crop for grazing and for hay; for production of seed for commercial purposes.

Clovers: Several standard varieties of clover to test adaptability to soil and climate.

Grasses: Several standard hay and pasture grasses to test adaptability to soil and climate.

Turnips: Kale, rape and mustard as winter cover crops for soil protection and for furnishing green stock feed in winter months.

Cotton: Some of the cross-bred varieties of cotton found growing seem to possess unusual merits as to productiveness and quality of staple, and extensive plant breeding and selection work has been undertaken that these good qualities may be maintained, if not further developed. Two or three hundred of the best stalks, representing a variety of types, have been

selected that this work may be carried on in a careful manner. The product of each stalk is being critically examined, and the best are to be grown next year for further observation and selection. I deem this the most important work that the Agricultural Division can take up at the present time.

The desideratum of the Experiment Station is the benefit to the farmers of the State by assisting them in securing better yields of products and products of better qualities without increasing the cost of production. The Agricultural Division, in its endeavor to reach these ends, is employing, through experimentation, the following means:

(1) Soil Improvement: a. By mechanical manipulation.
b. By fertilization.

(2) Plant Improvement: a. For increased quality.
b. For improved quality.

(1) The soil is the foundation of all agriculture, and the maintenance and increase of its fertility the basis of plant and animal production. The importance of demonstrating proper manipulation and rational fertilization of soils for various crops cannot be overestimated.

(2) Living things repeat their characteristics in their descendants and the perpetuation of desirable characteristics, whether natural or induced, is one of the most prolific fields for the production of permanent economic results. It is hoped that opportunity and facilities for thoroughly carrying on such work will be given the division.

Respectfully submitted,

C. L. Newman,

Associate Professor of Agriculture.

Report of the Secretary and Librarian.

Clemson College, S. C., Nov. 29, 1905.

Prof. J. N. Harper, Director, S. C. Experiment Station.

Dear Sir: Complying with your instructions, I beg to submit the following report of the work of the office division of the station covering the period of the fiscal year beginning July 1, 1904, and ending June 30, 1905.

The business of this office has continued to grow during the past year, and some new features have been especially de-

veloped, looking to increased efficiency, in diffusing among the people of this State, useful and practical information on subjects connected with agriculture. A Station Council has been organized under plans of the Board of Trustees, that will, at its regular meetings, discuss agricultural problems suited to the requirements of our large agricultural population,—and determine in a general way the character of the experiments for the ensuing year. The minutes of the deliberations of the Station Council are required to be carefully kept.

The activity and success of this station in bringing the results of its work before the agricultural public, continue unabated, as the work becomes more important and more necessary to the welfare of the farmers of the State.

During the year the station has issued one annual report, containing twenty-six pages and twenty-six (26) bulletins, many more than are required by the Hatch Act. These bulletins contain in the aggregate 326 pages, and they were published and distributed in editions of 12,000 copies. The total number of bulletins issued during the year were 312,000. Fifteen of the bulletins referred to above, containing the analyses of commercial fertilizers, were published at the College—and distributed from this office once a week, practically covering the period from the month of January to the end of April—thereby providing the farmers, on more than 10,000 farms in this State, with due notice regarding the quality of fertilizers offered for sale, and well-nigh preventing the sale of any fraudulent goods, in a business in which this State is interested to the amount of not less than $5,000,000. Some of the other bulletins referred to diseases of cattle, dairy management, agricultural and horticultural subjects. A striking evidence of a growing interest in all matters pertaining to this station, may be seen in the statement of the fact that we have made accessions of 1,250 names on the permanent mailing list, within the past year.

A complete file of all bulletins, representing every Experiment Station in the United States and many foreign States, is carefully kept, their numbers and subjects placed on record in the bulletin catalogue, and they are subsequently arranged in appropriate form and bound into volumes. There are now in the station library 430 of such bound volumes of bulletins. It may be

said that this work supplies the materials out of which a definite science of agriculture may be constructed—and on which shorter courses of instruction for various grades of agricultural students may be successfully based.

The edition of bulletin No. 89—"Sanitary Conditions in the Home and on the Farm" of this Station, has been exhausted during the present year and, as there is still considerable demand for it, I would recommend that it be reprinted in the near future.

Nothing so readily gives practical value and general importance to experiment station work as an extended dissemination of the reports of its progress and accomplishment, in the solution of agricultural problems. As represented by a report of the Department of Agriculture, Washington, D. C., the production in 1904, of cereals in this country, including corn, wheat, oats, barley and rye, expresses a value of $1,950,000,000. Now, a movement directed by the experiment stations that would increase the production only a few bushels per acre and add to the value only a few cents per bushel, would, if published and disseminated among the people, revolutionize the interest in these agricultural industries.

All of which is respectfully submitted,

John N. Hook,
Secretary and Librarian.

Report of the Horticulturist.

Clemson College, Nov. 29, 1905.

Prof. J. N. Harper, Director, S. C. Experiment Station, Clemson College, S. C.

Dear Sir: I submit the following report of the Horticultural Division of the South Carolina Experiment Station from July 1, 1904, to June 30, 1905:

A large number of the experiments conducted in the Horticultural Division are the same as those mentioned in my last report. It is necessary to continue the notes on the fruit trees, grape vines, etc., from year to year, in order to be able to make

satisfactory reports on the fruitfulness, hardiness and quality of the fruits.

Apples: The old apple orchard has borne a fairly good crop of fruit this season and has enabled us to make accurate notes on the various varieties of summer, fall and winter apples. Many of these varieties have proved to be well adapted to this section of the State, while others have proved to be of little value. We have issued a bulletin on the results of our experiments with the varieties of apples during the past eight years. We have also conducted experiments on the methods of grafting apples, with special reference to the length of scions and whole and piece roots. The results of these experiments will soon be ready for publication.

Peaches: In the old peach orchard a large number of the varieties that proved to be of no value have been removed and a young orchard consisting of new varieties that had not been tested here has been planted. This orchard will bear its first crop the coming season.

Pears: The majority of the trees in our old pear orchard have been destroyed by blight, the Garbers being the only variety remaining. A young pear orchard consisting of a number of varieties has been set and every effort will be made to control the blight, in order to give these varieties a thorough test.

Plums: We fruited forty-five varieties of plums during the past season. Many of these varieties proved to be of little value, while some were very satisfactory indeed. Thinning and pruning experiments were also conducted with various varieties of plums.

Cherries: Our young cherry orchard fruited for the first time the past season. Some of the varieties were worthless, while a half dozen seemed to be well suited to this section.

Pecans: We now have in bearing sixty seedling pecan trees. These trees were all grown from first-class nuts, and the nuts from the trees now bearing show conclusively that it is very necessary to either bud or graft the pecans in order to secure first-class nuts. Variation in the seedling pecan is very great. The nuts vary from 65 to 192 to the pound, while it only requires from 30 to 38 first-class pecans to make a pound. We

have also conducted experiments with the different methods of budding and grafting pecans.

Grapes: Our notes on the varieties of grapes have been continued. We now have notes completed on ninety-two varieties of grapes. The majority of these grapes have done very well indeed with us, while others have proved rather weak growers, and altogether unsatisfactory. Experiments in pruning the grapes have also been conducted.

Scuppernongs: We have conducted very interesting experiments in pruning grapes of the rotundi-folia type, and although it is usually supposed that it will not do to prune these grapes, the results of our experiments show that the yield has been doubled where the vines are properly pruned. We hope to be able to publish the results of these experiments.

Variety tests have been conducted with the following small fruits: Raspberries, blackberries and strawberries.

Celery: We tested twenty-four varieties of celery during the past season, six of which have proved to be exceptionally fine, while many of the other varieties have done fairly well, some have failed entirely. We have continued the variety tests of celery for the past four years, and also have conducted experiments with the different methods of bleaching and storing the celery for winter use.

Variety and culture tests have been carried on with the following vegetables: Cabbage, cauliflower, egg-plant, tomatoes, onions, muskmelons and Irish potatoes.

In our experiments with Irish potatoes, we have secured better results from our second crop than from the first. The past season we grew the first and second crop on the same ground and secured one-third more by weight from the second crop than from the first.

Our experiments with cauliflower have also been very satisfactory, 90 per cent. of some of the varieties producing first-class heads, while six or eight varieties proved to be utterly worthless.

For the past three years we have been conducting experiments with blue grass for lawns, comparing spring and fall sowing on sandy and clayey soils. Our experiments are very much in favor of the fall sowing and clayey soil. We find the grass will

die out during the summer on sandy soil, while it resists the drought very well indeed on the clayey soil. Grass sown in October has in every case stood the winter and following summer much better than grass sown in February. This experiment was undertaken on account of the large number of inquiries received by this Division on the subject of lawns.

Yours respectfully,

C. C. Newman,
Horticulturist.

Report of the Entomologist.

Clemson College, S. C., Dec. 6, 1905.

Prof. J. N. Harper, Director S. C. Experiment Station.

Dear Sir: The study of the injurious insects of rice, which was begun last year in collaboration with the botanist to determine the agency of insects in the distribution of the disease known as rice blast, has resulted in a contribution to the biology of several well-known and hitherto unknown injurious insects of this crop. During the coming year this work will be continued.

My work on the cattle tick in cooperation with the Bureau of Entomology, United States Department of Agriculture, has for its object the determination of the following facts in the life history of the parasite: the exact time occupied in different months in oviposition, the exact time occupied during each month of the year in the development of the embryo, the exact time during different months that seed ticks can exist without being attached to a host, and the exact time occupied in the different months in the parasitic stage. The majority of the entomologists in the Southern States have agreed to assist in this work, and through their combined efforts, there are good reasons to believe that, with the cooperation of our educated farmers, the cattle tick will be finally eradicated from this country.

In the capacity of a consulting zoologist, I am studying the "stomach worm," or "twisted wire worm, " (Strongylus contortus Rud.). This parasite is affecting the health and causing

the death of the calves and young cattle of this State at an alarming degree. I can only report progress in this work.

Among minor investigations of the year, I have given some attention to a borer in the stem of the cowpea plant, an insect that, judging from the reports, may become a serious pest of this crop. Although the insect was brought to my attention late in the season, I have succeeded in rearing the adult, a phycitid moth. The life history of this cowpea stem-borer will be studied closely next season with the view of securing some practical way of fighting it.

In the list of injurious insects that have caused alarm during the season, mention should be made of the following: In the trucking sections of the coast counties, the Irish potato plants were badly damaged by the Southern leaf-footed plant-bug, (Leptoglossus phyllopus Linn.). Some damage was done to the cotton crop in the northeastern part of the State by an unusual large brood of a large grasshopper (Schistocerca alutacea Harr.). During the midsummer droughts, the cotton in the central part of the State suffered from the attacks of the red spider (Tetranychus gloverii Bks.). The corn crop of the entire State was greatly reduced by the destructive work of the corn stalk-borer (Diatraea saccharalis Fab.). In many localities the wire worms caused great loss.

Respectfully submitted,

Chas. E. Chambliss,
Entomologist.

Report of the Botanist and Bacteriologist.

Clemson College, S. C., Dec. 6, 1905.

Prof. J. N. Harper, Director, S. C. Experiment Station.

Dear Sir: I beg to submit the following report:

The work in this Division has been continued under hopeful auspices with reference to the future, but with practically the same limitations as in the past. At the beginning of the fall term, the Division was moved into the Agricultural Building. The new quarters, while ultimately much better than the old, are not yet sufficiently equipped to be entirely efficient. The

continued delay in the erection of a greenhouse has occasioned a continuance of same disadvantages in working that have been described in previous reports. It is pleasing to note that at the date of writing, the prompt erection of a greenhouse appears to be assured.

Practically all of the time that the writer has been able to spare for investigation has been spent in the study of the rice blast. As stated in a preceding report, this is the only disease in the State that has threatened the existence of a great industry, and this critical situation has seemed to justify the expenditure of all of the botanist's time. The month of August, and portions of February, March, June, July and September have been spent in the rice district. Laboratory work on the disease has continued throughout the year, but in the absence of greenhouse facilities, it has been impossible to make inoculation experiments. I have no hesitation in saying that the use of a greenhouse during the past winter would have doubled the efficiency of my work and hastened its completion by six months. As it is, a great deal has been accomplished and the botanist will shortly be able to turn over the work in the form of an agricultural problem, the legitimate pathological work having been completed with the exception of certain features which require the use of a greenhouse. The details of the work and the results are not presented here, as a bulletin relating to the same will very shortly be issued. This work on the blast of rice has been carried on in cooperation with the Division of Vegetable Pathology of the United States Department of Agriculture.

The regular correspondence of the Division, which appears to be all the time increasing, has in the meantime been maintained. Preliminary investigations to those intended to run through a long term of years have been undertaken, with reference to the bacterial flora of soil of the Piedmont region. Observations on local sanitary conditions, as well as similar observations in the rice district of the State, have been continued, and two bulletins on the matter will shortly be issued. Bulletin 89, on sanitary subjects, has been exhausted. The great interest in sanitary matters manifested by this fact and by the amount of correspondence on the subject, indicates that this is

one of the most popular subjects for investigation, and it is needless to say that it is one of the most necessary subjects to be well understood. Upon the completion of the rice work, it would seem that this is the most hopeful line of investigation to be developed by this Division of the Station.

During his activity as botanist of this station, the writer has concentrated his work entirely upon pathological and bacteriological problems. There are, however, certain purely botanical problems that stand in urgent need of investigation and study. Among these are: (1) The question of seed purity and other matters regarding the commercial standard of seeds purchased in this State; (2), the problem of the utilization in cultivation of the many (almost unknown) native legumes; (3), a definite and thorough survey of the phanerogams of the State. All three of these problems are of fundamental importance, and it is to be hoped that they may be taken up within the next few years.

Respectfully submitted,

Haven Metcalf,
Botanist and Bacteriologist.

Report of the Veterinarian.

Clemson College, S. C., Nov. 28, 1905.

Prof. J. N. Harper, Director, South Carolina Experiment Station.

Dear Sir: I have the honor to submit the following statement of the work of the Veterinary Division of the Experiment Station:

On taking charge of this Division on November 1, 1904, I found awaiting attention several letters requesting information regarding a disease that was affecting calves and, in most cases, resulting fatally. As the disease could not be identified from the facts given by the correspondents, and as it appeared to be prevailing quite extensively and causing considerable losses, an investigation was made. The disease was found to exist on twenty-five farms in the northwestern part of the State, and from a study of the cases on five farms near the station, it was

found to be due to the presence of a small worm, the "twisted wire worm" or *strongylus contortus,* in large numbers in the fourth stomach of the affected animals. Medical treatment was prescribed which proved very successful in checking the disease, and methods were recommended for the eradication of the worms from the infested farms. A full account of the conditions under which the disease occurred, the symptoms, the appearance of the worm and the method of treatment was published in Bulletin No. 114. The study of the disease is being continued during the current year, in cooperation with the Division of Entomology and Zoology, to obtain additional information regarding the life habits of the parasite and the best practical means of eradicating it from infested farms.

Experiments were also made in connection with the treatment of "scours" in milk-fed calves, a disease which has proven very troublesome to those raising skim-milk calves. A method of treatment was discovered which proved very successful, and which it is believed will be of great value. The results of this work will soon be ready for publication in bulletin form.

Some preliminary work was done in the study of nodular disease of sheep, and information was obtained which will be of use when the subject can be taken up for further investigation.

The experiment begun by my predecessor with reference to the means of prevention and the treatment of parturient apoplexy (milk fever) of cattle, has been continued as opportunity afforded, but, as the work can only be prosecuted as cases occur in the station herd, and as these cases have been rather rare, a sufficient amount of data is not yet in hand for publication of results.

The plans of the Division for the ensuing year include, in addition to the work mentioned above, a series of co-operative experiments between a number of farmers in the State, this Division of the station, and the United States Department of Agriculture in testing several methods of eradicating the cattle tick from the farms and freeing the cattle of this parasite.

Respectfully submitted,

Louis A. Klein,
Veterinarian.

Report of the Dairy and Animal Husbandman.

Clemson College, S. C., Nov. 28, 1905.

Prof. J. N. Harper, Director, S. C. Experiment Station.

Dear Sir: In accordance with your request, I present herewith a report of the work of the Department of Animal Husbandry and Dairying for the year ending December 31, 1905:

During the early part of the year the work of the department was in charge of the assistant, Mr. B. H. Rawl, who had outlined a number of experiments for the ensuing year. About the time these experiments were to be put into execution, Mr. Rawl received an appointment with the National Department of Agriculture, and Mr. J. M. Burgess was appointed his successor. As a result of these changes, no experiments were in progress in the department when the writer assumed charge in July, 1905. The work done since that time is briefly stated as follows:

Definite and systematic plans have been made with reference to the work with the different classes of live stock. It is our aim to build up a pure bred herd of strictly dairy animals, and also a pure bred herd of strictly beef animals.

In addition, grade herds are to be established by using the pure bred sires upon our common or native cattle. Similar plans have been made with reference to sheep and swine. It is believed that grading up with pure bred sires is the most feasible plan for the improvement of the live stock of South Carolina. The following pure bred animals of the highest types have already been purchased: A Jersey bull, a Jersey heifer, a Berkshire boar, and a Southdown ram. The department is now looking for a typical beef bull, which will in all probability be purchased in a very short time.

Plans have been completed for the construction of a piggery and sheep shed, and there is promise of having the buildings ready for occupancy by January 1, 1906. The breeding of horses and mules, a project now in contemplation, will also necessitate the construction of a horse barn.

During July a manure pit, with cement lining, was constructed by means of which it is possible to save all of the liquid as well as the solid excreta of farm animals.

A three months' feeding trial with twenty-two cows has just been completed. The experiment had for its object a study of the comparative value of wheat bran and cotton seed meal for milk production. The results will be published in bulletin form in the near future. The cotton seed meal experiments will be continued.

A bulletin on dairy farming is now in press and will be ready for distribution in a few weeks. A bulletin is also in preparation on the value of gathered cream plants for South Carolina.

Yours respectfully, JOHN MICHELS,
Dairy and Animal Husbandman.

Report of Chemist.

CLEMSON COLLEGE, S. C., Dec. 1, 1905.

President P. H. Mell.

Sir: I respectfully submit the following report of the Chemical Department of the Station for the year ending June 30, 1905:

The study of the production of starch from the sweet potato has been resumed. The work already done here on the subject has been reported in Bulletins 28, 30 and 63 of this Station. It is now proposed to erect a small experimental plant for the manufacture of the starch, and to have the product and by-product submitted to practical tests.*

With regard to what has been accomplished during the year, I have to report the following work of Mr. F. S. Shiver, assistant chemist: A chemical study of the tea industry in South Carolina, published in part. A chemical study of the tobacco industry in South Carolina, completed but not published. A considerable amount of work done in cooperation with the referees on insecticides and on dairy products, for the Association of Official Agricultural Chemists. A good deal of work for the Agricultural Department of the station in testing the burning qualities of tobacco grown under different conditions. Finally some miscellaneous work, including analysis of soils.

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*At this writing (December 1st) the building is completed and the necessary machinery is in place. The equipment of the factory as well as the chemical work is under the supervision of Mr. C. C. McDonnell, Assistant Chemist.

ANALYSIS OF COMMERCIAL FERTILIZERS.

Following is a report of the work on commercial fertilizers done under the direction of the Fertilizer Control Committee of the Board of Trustees:

	Season 1903-04.	Season 1904-05.
Official samples	402	522
Farmers' samples	125	19
Special official samples of cotton seed meal		84
	527	625

The small number of "farmers' samples" this year is due in part to the collection of samples at farms by the official inspectors instead of by the farmers themselves.

OFFICIAL SAMPLES OF FERTILIZERS.

The number of samples analyzed this year is 522. The analyses are given in full in Bulletin 115. The 84 samples of cotton seed meal collected at mills by special order of the Board of Fertilizer Control are not included here. The results of this investigation were fully reported in Bulletin 105.

CLASSIFICATION.

	1904.	1905.
Complete fertilizers	180	250
Acid phosphates	59	81
Acid phosphates with potash	75	82
Cotton seed meal	57	62
Kainit	11	26
Nitrate of soda	6	7
Muriate of potash	7	6
Sulphate of potash	2	0
Nitrate of soda with potash	0	1
Ground fish	2	3
Sulphate of ammonia	1	0
Tankage	1	0

	1904.	1905.
Dried blood	0	1
Miscellaneous	1	3
Total	402	522

DEFICIENT SAMPLES.

Of the 522 samples analyzed in 1905, thirteen brands were deficient under the law.

In addition to these, there were 165 samples which fell below the guarantee in one or more constituents, as follows:

In available phosphoric acid	35
In available phosphoric acid and ammonia	2
In available phosphoric acid and potash	1
In ammonia and potash	13
In ammonia	61
In potash	53
Total	165

The extent to which they fell below guarantee is shown in the following table:

	Below Guarantee—Per Cent.				
	.0-.10	.10-.25	.25-.50.	.50-1.00	1.00 and Over
In available phosphoric acid	7	13	6	8	4
In ammonia	25	29	17	5	0
In potash	8	22	20	12	5
Total	40	64	43	25	9

The number of brands deficient under the law is smaller this season than last. Thirteen out of 522, opposite 18 out of 402, or 2.49 per cent. opposite 4.48 per cent.

The relative number of samples falling below guarantee in one or more constituents, though not deficient in accordance with law, differs but little from last season, there being 165 out of 522, opposite 124 out of 402, or 31.61 per cent., opposite 30.85 per cent.

AVERAGES OF ANALYSES.

	1904. Per Cent.		1905. Per Cent.	
	Found.	Guaranteed.	Found.	Guaranteed.
ACID PHOSPHATES.				
Soluble phosphoric acid	11.09	.....	11.49	.....
Reverted phosphoric acid	3.23	.....	3.32	.....
Available phosphoric acid	14.32	13.61	14.81	13.99
Insoluble phosphoric acid	.78	.....	.76	.....
Total phosphoric acid	15.10	.....	15.57	.....
ACID PHOSPHATES WITH POTASH.				
Soluble phosphoric acid	7.33	.....	7.65	.....
Reverted phosphoric acid	3.79	.....	3.05	.....
Available phosphoric acid	11.12	10.13	10.70	9.98
Insoluble phosphoric acid	.82	.....	.66	.....
Total phosphoric acid	11.94	.....	11.36	.....
Potash soluble in water	2.81	2.71	3.07	3.03
COMPLETE FERTILIZERS.				
Soluble phosphoric acid	6.16	.....	6.45	.....
Reverted phosphoric acid	2.96	.....	2.74	.....
Available phosphoric acid	9.12	8.27	9.19	8.21
Insoluble phosphoric acid	1.50	.....	1.48	.....
Total phosphoric acid	10.62	.....	10.67	.....
Ammonia	2.99	2.93	3.12	3.05
Potash soluble in water	2.90	2.71	2.90	2.71
COTTONSEED MEALS.				
Available phosphoric acid	2.28	1.54	2.41	1.52
Ammonia	7.92	7.06	7.42	6.91
Potash soluble in water	1.54	1.21	1.54	1.01
KAINITS.				
Potash soluble in water	12.94	12.00	12.54	12.00
MURIATE OF POTASH.				
Potash soluble in water	49.79	49.72	50.49	49.33
SULPHATE OF POTASH.				
Potash soluble in water	53.47	.....	.....	.....
NITRATE OF SODA.				
Ammonia (equivalent)	18.87	18.00	18.73	16.86

There were five samples of Sea Island meal this year. They are not included in the foregoing table. They averaged 4.73 per cent. of ammonia found, 4.80 per cent. guaranteed.

The available phosphoric acid and potash in cotton seed meal were guaranteed in only forty-one samples, but these ingredients were determined in all cases.

With regard to the 84 samples of cotton seed meal collected at mills by special order of the Board of Fertilizer Control, the following averages are presented:

	Found. Per cent.	Guaranteed. Per cent.
Available phosphoric acid	2.34	1.50
Ammonia	7.52	7.05
Potash soluble in water	1.56	1.00

The following table shows the yearly averages of fertilizer analyses from the time the Board of Trustees of this College took charge of the station work down to the present time:

YEARLY AVERAGES OF ANALYSES FROM 1891 TO 1904, INCLUSIVE.

Season.	Acid Phosphates.		Acid Phosphates with Potash.			Complete Fertilizers.				Cottonseed Meals.				Kainits.		Muriate of Potash.		Nitrate of Soda.	
	Number of Samples.	Available Phosphoric Acid, Per Cent.	Number of Samples.	Available Phosphoric Acid, Per Cent.	Potash Soluble in Water, Per Cent.	Number of Samples.	Available Phosphoric Acid, Per Cent.	Ammonia, Per Cent.	Potash Soluble in Water, Per Cent.	Number of Samples	Available Phosphoric Acid, Per Cent.	Ammonia, Per Cent.	Potash Soluble in Water, Per Cent.	Number of Samples.	Potash, Per Cent.	Number of Samples.	Potash, Per Cent.	Number of Samples.	Ammonia, Per Cent.
1890-1. . . .	49	13.02	19	11.84	1.65	173	9.34	2.68	1.96	30	.....	8.37	.....	21	12.75	1	51.96	1	19.22
1891-2. . . .	29	12.92	16	11.50	1.49	112	8.83	2.80	1.95	25	.....	8.21	.....	18	12.51	.....	.....	1	18.63
1892-3. . . .	48	12.32	26	11.63	1.22	150	9.00	2.91	1.65	20	2.62	8.40	1.32	20	12.05	.....	.....	.....	.....
1893-4. . . .	46	13.24	22	12.01	1.51	132	9.27	2.53	1.79	22	2.45	8.64	1.69	17	12.37	.....	.....	.....	.....
1894-5. . . .	46	13.55	15	12.09	1.66	87	9.42	2.55	1.77	33	2.58	8.19	1.66	19	12.30	.....	.....	.....	.....
1895-6. . . .	42	13.43	26	11.99	1.39	115	9.31	2.64	1.86	34	2.57	8.45	1.61	16	12.45	.....	.....	.....	.....
1896-7. . . .	59	13.61	34	12.06	1.61	117	9.55	2.70	1.91	40	2.53	8.69	1.64	22	12.44	.....	.....	.....	.....
1897-8. . . .	63	13.67	50	11.54	2.06	141	9.15	2.70	1.93	39	2.37	8.39	1.58	20	12.68	.....	.....	1	19.23
1898-9. . . .	73	13.74	68	11.77	1.99	134	9.32	2.73	2.21	40	2.76	8.25	1.75	14	12.78	2	51.93	2	18.96
1899-1900 . .	73	13.58	63	11.58	2.00	124	9.50	2.73	2.13	52	2.27	8.73	1.63	8	12.73	4	50.95	3	19.01
1900-1. . . .	56	14.00	55	11.49	2.65	139	9.40	2.87	2.47	60	2.38	8.55	1.54	12	12.61	2	48.92	3	18.96
1901-2. . . .	45	14.11	51	11.09	2.55	141	9.39	2.84	2.34	49	2.57	7.93	1.63	16	12.85	4	50.54	3	19.03
1902-3. . . .	51	13.74	55	10.94	2.65	139	9.02	2.69	2.42	69	2.27	8.08	1.48	15	12.92	2	50.25	2	19.15
1903-4. . . .	59	14.32	75	11.12	2.81	180	9.12	2.99	2.90	57	2.28	7.92	1.54	11	12.94	7	49.79	6	18.87
1904-5. . . .	81	14.81	82	10.70	3.07	250	9.19	3.12	2.90	62	2.41	7.42	1.54	26	12.54	6	50.49	7	18.73

In this table, as in the foregoing ones, the ammonia yielded by the nitrogen in fertilizers is given instead of the nitrogen itself, as in the trade goods are still bought and sold on the ammonia basis. The per cent. of nitrogen is readily calculated, as fourteen-seventeenths of the weight of the ammonia is practically the weight of the nitrogen it contains.

There still continues the general improvement in the character of acid phosphates and complete fertilizers which was noted in the last annual report.

With regard to cotton seed meals, it is to be observed that the average percentage of ammonia is even less than it was last year.

GRADES.

In the following table the number of acid phosphates, acid phosphates with potash, and complete fertilizers of each grade, according to guarantee, is placed side by side with the number found by analysis to belong to that grade, fertilizers having commercial values equal to those of schedule grades being classed in those grades:

	High.		Standard.		Low.	
	Claimed.	Found.	Claimed.	Found.	Claimed.	Found.
Complete fertilizers..(250)	118	133	124	111	8	6
Acid phosphates with potash .....(82)	38	73	42	7	2	2
Acid phosphates .....(81)	79	76	2	5	0	0
Total .....(413)	235	282	168	123	10	8

These results are due to the following changes in grades ascertained by analysis:

	Low to High.	Low to Standard.	Standard to High.	High to Standard.	High to Low.	Standard to Low.	No Change.
Complete fertilizers ....(250)	0	4	18	3	0	2	223
Acid phosphates .....(81)	0	0	1	4	0	0	76
Acid phosphates with potash .....(82)	1	0	34	0	0	1	46
Total .....(413)	1	4	53	7	0	3	345

This shows that out of 413 samples, 345 were of the grade claimed for them, 58 were of a higher grade and 10 of a lower grade than that claimed for them.

Last year out of 314 samples, 256 were of the grade claimed for them, 44 were of a higher grade, and 23 of a lower grade than that claimed for them.

This matter of grades is to some extent misleading, as there may easily be a difference of several dollars a ton in the money value of fertilizers or of cotton seed meals included in the same schedule grades. In purchasing the farmer should be governed not by the "grade" claimed, but by the percentages of the essential constituents which are guaranteed.

FARMERS' SAMPLES OF FERTILIZERS.

In addition to the samples of fertilizers collected by the official inspectors, there have been analyzed 19 samples for individual farmers in accordance with Section 1540 of the law with regard to commercial fertilizers. It is to be remarked, however, that 49 of the 522 official samples were drawn by the regular inspectors at the request of farmers who preferred this method, so that really 68 samples in all have been analyzed for individual purchasers.

WATER.

There have been made during the year 34 sanitary examinations and 21 complete analyses of waters from different parts of the State.

COOPERATIVE WORK.

Mr. C. C. McDonnell and Mr. F. C. Atkinson, assistant chemists, have done a considerable amount of work in cooperation with the referee on potash, for the Association of Official Agricultural Chemists.

DISTRIBUTION OF THE WORK.

Fertilizers were analyzed by Messrs. C. C. McDonnell, B. F. Robertson, F. C. Atkinson and W. E. Dickinson; waters by Mr. D. H. Henry. Dr. R. N. Brackett has aided me in office duties.

Very respectfully,

M. B. Hardin,
Chief Chemist.

OF THE
UNIVERSITY OF ILLINOIS
23 APR 1915

NINETEENTH ANNUAL REPORT

OF THE

South Carolina Experiment Station

OF THE

CLEMSON AGRICULTURAL COLLEGE

FOR THE YEAR ENDING

JUNE 30, 1906

COLUMBIA, S. C.
THE R. L. BRYAN COMPANY
1906

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M. B. Hardin, *Chief Chemist.*
C. C. Newman, *Horticulture.*
C. E. Chambliss, M. S., *Entomology and Zoology.*
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John Michels, M. S. A., *Animal Husbandry and Dairying.*
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R. N. Brackett, Ph. D., *Chemistry.*
John N. Hook, *Secretary and Librarian.*
C. C. McDonnell, B. S., *Chemistry and Fertilizer Control.*
B. F. Robertson, B. S., *Chemistry and Fertilizer Control.*
D. H. Henry, B. S., *Chemistry.*
W. E. Dickinson, B. S., *Chemistry Assistant (Fertilizer Control).*
J. H. Mitchell, M. S., *Chemistry Assistant (Fertilizer Control).*
J. M. Burgess, B. S., *Herdsman.*
W. D. Garrison, B. S., *Foreman of Station Farm.*
J. M. Jenkins, B. S., *Foreman Coast Land Experiment Station.*
Miss Helen Bradford, *Stenographer.*

Mail and telegraph: Clemson, S. C.

Freight and express: Calhoun, S. C.

The bulletins of the Station are issued at irregular intervals, and are sent free to all citizens of the State who apply for them.

CLEMSON COLLEGE, S. C., November 20, 1906.

Hon. D. C. Heyward, Governor of South Carolina.

Sir: I have the honor to submit herewith the nineteenth Annual Report of the South Carolina Agricultural Experiment Station, in accordance with the requirements of an Act of Congress approved March 2, 1887, for the Establishment of Agricultural Experiment Stations in connection with the Colleges of the several States, organized under the provisions of an Act approved July 2, 1862.

Respectfully submitted,

P. H. MELL,
President.

THE SOUTH CAROLINA EXPERIMENT STATION
HATCH FUND,

In Account with
THE UNITED STATES APPROPRIATION, 1905-1906.

DR.

To Receipts from the Treasurer of the United States, as per appropriation for fiscal year ended June 30, 1906, as per Act of Congress, approved March 2, 1887 ..... $15,000 00

CR.	ABSTRACT.	
By Salaries	1	$10,821 38
Labor	2	1,448 56
Publications	3	630 00
Postage and stationery	4	94 54
Freight and express	5	87 56
Heat, light, water and power	6	83 73
Chemical supplies	7	400 22
Seeds, plants and sundry supplies	8	357 03
Fertilizers	9	264 48
Feeding stuffs	10	48 22
Library	11	105 80
Tools, implements, and machinery	12	172 47
Furniture and fixtures	13	11 50
Scientific apparatus	14	
Live stock	15	16 00
Traveling expenses	16	148 92
Contingent expenses	17	56 11
Building and repairs	18	253 48
Balance		
Total		$15,000 00

We, the undersigned, duly appointed Auditors of the Corporation, do hereby certify that we have examined the books and accounts of the Treasurer of the Hatch Fund for the fiscal year ended June 30, 1906; that we have found the same well kept and classified as above, and that the receipts for the year from the Treasurer of the United States are shown to

have been $15,000.00, and the corresponding disbursements $15,000.00; for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving

And we further certify that the expenditures have been solely for the purposes set forth in the Act of Congress approved March 2, 1887.

Signed:

R. W. SIMPSON,
Chairman Finance Committee, Auditors.

Attest:

P. H. E. SLOAN,
Custodian.

THE SOUTH CAROLINA EXPERIMENT STATION
ADAMS FUND,

In Account with
THE UNITED STATES APPROPRIATION, 1905-1906.

DR.

To Receipts from the Treasurer of the United States, as per appropriation for fiscal year ended June 30, 1906, as per Act of Congress, approved March 16, 1906.....$..... $5,000 00

CR.	ABSTRACT.		
By Salaries	1	$.....	
Labor	2	25 00	
Publications	3	.....	
Postage and stationery....	4	43 50	
Freight and express.....	5	118 75	
Heat, light, water and power	6	.....	
Chemical supplies	7	10 00	
Seeds, plants and sundry supplies	8	28 87	
Fertilizers	9	.....	
Feeding stuffs	10	154 90	
Library	11	.....	
Tools, implements, and machinery	12	132 50	

Furniture and fixtures	13	.....	
Scientific apparatus	14	498 70	
Live stock	15	2,295 00	
Traveling expenses	16	2 90	
Contingent expenses	17	.....	
Building and repairs	18	250 00	
			3,560 12
Balance			1,439 88
Total			$5,000 00

We, the undersigned, duly appointed Auditors of the Corporation, do hereby certify that we have examined the books and accounts of the Treasurer of the South Carolina Experiment Station for the fiscal year ended June 30, 1906; that we have found the same well kept and classified as above, and that the receipts for the year from the Treasurer of the United States are shown to have been $5,000.00, and the corresponding disbursements $3,560.12, for; for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving $1,439.88.

And we further certify that the expenditures have been solely for the purposes set forth in the Act of Congress approved March 16, 1906.

Signed:

R. W. SIMPSON,
Chairman Finance Committee, Auditors.

Attest:

P. H. E. SLOAN,
Custodian.

REPORT OF THE DIRECTOR.

CLEMSON COLLEGE, S. C., November 20, 1906.

Dr. P. H. Mell, President Clemson College.

Dear Sir: I have the honor to submit herewith the Annual Report of the South Carolina Agricultural Experiment Station for the fiscal year ending June 30th, 1906:

The work of the station is becoming more efficient, due to increased equipment and to the fact that the college work has

been arranged so that more time could be devoted to research work. Since the station income from the Federal Government will be considerably increased on account of the passage of the Adams Bill, our experimental work can be greatly enlarged and carried out with more thoroughness. To obtain the best results, it will be our policy to undertake only a limited number of experiments, and only those the results of which will be of the greatest practical value to our farmers.

An accurate map has been made of the experiment station grounds, and the results of each plot can be definitely located and recorded. The experimental work of the Agricultural Division pertaining to the production and improvement of plants has been assigned to the supervision of the agriculturist, and those experiments pertaining to soil improvement and the use of commercial fertilizers will be under the supervision of the Director.

The new greenhouse erected on the campus out of the college funds has been completed. This greenhouse is thoroughly modern in every respect, and the station officers are grateful to the college authorities for such a building. This greenhouse will greatly increase the opportunities of the station for work. The Divisions of Horticulture, Entomology, Agronomy, Botany and Soils will conduct experiments in this building.

During the past year, eight of the officers of the experiment station devoted a portion of their time to Farmers' Institute work.

The work of the Coast Land Experiment Station, located at Charleston, continues to pursue a line of experiments with forage plants. Some valuable results have been obtained from these experiments. Enormous yields of hay per acre have been harvested from alfalfa, beggar weed, teosinte, sorghum, cowpeas, Kafir corn, barley, rye, oats, and wheat, when the proper cultivation and fertilizers were applied.

The appended reports summarize fully the details of this year's experiments.

Thanking you most heartily for your kindly interest in this work, and for valuable suggestions you constantly give us, I remain

Yours very respectfully, J. N. HARPER,
Director.

REPORT OF CHEMIST.

CLEMSON COLLEGE, S. C., November 1, 1906.

Prof. J. N. Harper, Director S. C. Experiment Station.

Sir: I respectfully submit the following report of the Chemical Department of the station for the year ending June 30, 1906:

In the small experimental plant, which was erected and equipped with the necessary machinery last year, several hundred pounds of starch were made from sweet potatoes. The work was commenced late in the season and the potatoes were mainly of one variety, but it was thought advisable to make a few runs of starch in order to test the machinery and the character of the product. Under the circumstances the results were encouraging. Samples of the starch were tested at a few cotton mills and laundries, and very favorable reports were received. The pulp left as a by-product, after the extraction of the starch, promises to make a useful cattle food. There was not enough of it for any extended trials in feeding, but the Professor in charge of the Dairy Division of the station was sufficiently interested to express a desire to continue the investigation of its merits this year.

Certain changes in the machinery of the plant are now being made, with the view of increasing the yield of starch. It is also intended to try different varieties of sweet potatoes in order to ascertain the kind best suited for the manufacture. The numerous analyses of the potatoes, starch and pulp were made by Mr. C. C. McDonnell, who has also had charge of the erection and equipment of the experimental plant and of the process of manufacturing the starch.

The work done this year by Mr. F. S. Shiver has been of a co-operative nature. He has analyzed 12 samples of wheat for the Director of the station, making both protein and moisture determinations. He has also co-operated with the Professor of Dairying in studying the conditions which affect the water content of butter. In this investigation he determined water, fat, casein and salt in 55 samples.

In addition to the work mentioned there have been analyzed a sample of marl for the Director of the station, and a sample of cottonseed meals for Mr. V. P. Hudson, of Greenville, S. C. These analyses were made by Mr. D. H. Henry.

ANALYSES OF COMMERCIAL FERTILIZERS.

Following is a report of work on commercial fertilizers, done under the direction of the Fertilizer Control Committee of the Board of Trustees:

	Season 1904-5.	Season 1905-6.
Official samples	522	655
Farmers' samples	19	48
Special official samples of cottonseed meal	84	—
	625	703

OFFICIAL SAMPLES OF FERTILIZERS.

The number of samples analyzed this year is 655.
The analyses are given in full in Bulletin No. 119.

Classification.

	1905.	1906.
Complete fertilizers	250	325
Acid phosphates	81	87
Acid phosphates with potash	82	94
Cottonseed meal	62	79
Kainit	26	29
Nitrate of soda	7	19
Muriate of potash	6	13
Sulphate of potash	0	2
Nitrate of soda with potash	1	2
Ground fish	3	0
Tankage	0	2
Dried blood	1	1
Miscellaneous	3	2
Total	522	655

Deficient Samples.

Of the 655 samples analyzed in 1906, thirty were deficient under the law. In addition to these, there were 201 samples which fell below the guarantee in one or more constituents, as follows:

In available phosphoric acid	22
In available phosphoric acid and ammonia	1
In available phosphoric acid and potash	2
In available phosphoric acid, ammonia and potash	0
In ammonia and potash	27
In ammonia	87
In potash	62
Total	201

The extent to which they fall below guarantee is shown in the following table:

	Below Guarantee			Per Cent.	
	.0-.10	.10-.25	.25-.50	.50-1.00	1.00 & over
In available phos. acid..	6	1	10	6	2
In ammonia	37	41	29	8	0
In potash	15	24	27	21	4
Total,	58	66	66	35	6

The number of samples deficient under the law is greater this season than last. Thirty out of 655 opposite seventeen (representing thirteen brands) out of 522 in 1905, or 4.58 per cent. opposite 3.26 per cent.

The relative number of samples falling below guarantee in one or more constituents, though not deficient in accordance with law, is a little less than last season, there being 201 out of 655, opposite 165 out of 522, or 30.68 per cent. opposite 31.61 per cent.

AVERAGES OF ANALYSES.

	1905. Per Cent.		1906. Per Cent.	
	Found	Gua'rt'd	Found	Guar't'd
ACID PHOSPHATES—				
Soluble phosphoric acid	11.49	.....	11.71	.....
Reverted phosphoric acid	3.32	.....	3.24	.....
Available phosphoric acid	14.81	13.99	14.95	14.03
Insoluble phosphoric acid	.76	.....	.60	.....
Total phosphoric acid	15.57	.....	15.55	.....
ACID PHOSPHATES WITH POTASH—				
Soluble phosphoric acid	7.65	.....	7.80	.....
Reverted phosphoric acid	3.05	.....	3.17	.....
Available phosphoric acid	10.70	9.98	10.97	9.97
Insoluble phosphoric acid	.66	.....	.63	.....
Total phosphoric acid	11.36	.....	11.60	.....
Potash soluble in water	3.07	3.03	3.30	3.15
COMPLETE FERTILIZERS—				
Soluble phosphoric acid	6.45	.....	6.54	.....
Reverted phosphoric acid	2.74	.....	2.80	.....
Available phosphoric acid	9.19	8.21	9.34	8.21
Insoluble phosphoric acid	1.48	.....	1.39	.....
Total phosphoric acid	10.67	.....	10.73	.....
Ammonia	3.12	3.05	3.26	3.23
Potash soluble in water	2.90	2.71	2.98	2.74
COTTON SEED MEALS—				
Available phosphoric acid	2.41	1.52	2.42	1.47
Ammonia	7.42	6.91	7.51	7.11
Potash soluble in water	1.54	1.01	1.57	1.00
KAINIT—				
Potash soluble in water	12.54	12.00	12.83	12.00
MURIATE OF POTASH—				
Potash soluble in water	50.49	49.33	50.05	48.50
SULPHATE OF POTASH—				
Potash soluble in water	.....	.....	49.57	48.00
NITRATE OF SODA—				
Ammonia (equivalent)	18.73	16.86	18.67	18.21

There were 8 samples of Sea Island meal this year. They are not included in the foregoing table. They averaged 4.71 per cent. of ammonia found, 4.81 per cent. guaranteed.

The following table shows the yearly averages of fertilizer analyses from the time the Board of Trustees of this college took charge of the station work down to the present time:

YEARLY AVERAGES OF ANALYSES FROM 1891 TO 1906, INCLUSIVE

SEASON	Acid Phosphates		Acid Phosphates with Potash			Complete Fertilizers				Cotton Seed Meals				Kainits		Muriate of Potash		Nitrate of Soda	
	Number of Samples	Available Phosphoric Acid Per Cent.	Number of Samples	Available Phosphoric Acid Per Cent.	Potash Soluble in Water Per Cent.	Number of Samples	Available Phosphoric Acid Per Cent.	Ammonia Per Cent.	Potash Soluble in Water Per Cent.	Number of Samples	Available Phosphoric Acid Per Cent.	Ammonia Per Cent.	Potash Soluble in Water Per Cent.	Number of Samples	Potash Per Cent.	Number of Samples	Potash Per Cent.	Number of Samples	Ammonia Per Cent.
1890–1	49	13.02	19	11.84	1.65	173	9.34	2.68	1.96	30	.....	8.37	.....	21	12.75	1	51.96	1	19.22
1891–2	29	12.92	16	11.50	1.49	112	8.83	2.80	1.95	25	.....	8.21	.....	18	12.51	....	.....	1	18.63
1892–3	48	12.32	26	11.63	1.22	150	9.00	2.91	1.65	20	2.62	8.40	1.32	20	12.05	....	.....	....	.....
1893–4	46	13.24	22	12.01	1.51	132	9.27	2.53	1.79	22	2.45	8.64	1.69	17	12.37	....	.....	....	.....
1894–5	46	13.55	15	12.09	1.66	87	9.42	2.55	1.77	33	2.58	8.19	1.66	19	12.30	....	.....	....	.....
1895–6	42	13.43	26	11.99	1.39	115	9.31	2.64	1.86	34	2.57	8.45	1.61	16	12.45	....	.....	....	.....
1896–7	59	13.61	34	12.06	1.61	117	9.55	2.70	1.91	40	2.53	8.69	1.64	22	12.44	....	.....	....	.....
1897–8	63	13.67	50	11.54	2.06	141	9.15	2.70	1.93	39	2.37	8.39	1.58	20	12.68	....	.....	1	19 23
1898–9	73	13.74	68	11.77	1.99	134	9.32	2.73	2.21	40	2.76	8.25	1.75	14	12.78	2	51.93	2	18.96
1899–1900	73	13.58	63	11.58	2.00	124	9.50	2.73	2.13	52	2.27	8.73	1.63	8	12.73	4	50.95	3	19.01
1900–1	56	14.00	55	11.49	2.65	139	9.40	2.87	2.47	60	2.38	8.55	1.54	12	12.61	2	48.92	3	18.96
1901–2	45	14.11	51	11.09	2.55	141	9.39	2.84	2.34	49	2.57	7.93	1.63	16	12.85	4	50.54	3	19.03
1902–3	51	13.74	55	10.94	2.65	139	9.02	2.69	2.42	69	2.27	8.08	1.48	15	12.92	2	50.25	2	19.15
1903–4	59	14.32	75	11.12	2.81	180	9.12	2.99	2.90	57	2.28	7.92	1.54	11	12.94	7	49.79	6	18.87
1904–5	81	14.81	82	10.70	3.07	250	9.19	3.12	2.90	62	2.41	7.42	1.54	26	12.54	6	50.49	7	18.73
1905–6	87	14.95	94	10.97	3.30	375	9.34	3.26	2.98	71	2.42	7.51	1.57	29	12.83	13	50.05	19	18.67

In this table, as in the foregoing ones, the ammonia yielded by the nitrogen in fertilizers is given instead of the nitrogen itself, as in the trade, goods are still bought and sold on the ammonia basis. The per cent. of nitrogen is readily calculated, as fourteen-seventeenths of the weight of the ammonia is practically the weight of the nitrogen it contains.

It will be observed that the average percentage of the fertilizing ingredients in acid phosphates and mixed fertilizers are higher this year than last.

The increase in the production of higher grade goods in recent years was referred to in the Annual Reports for 1904 and 1905. It is gratifying to see that the progress in this direction still continues, for it is, as stated in the Annual Report for 1904, doubtless due to the demands of farmers, who realize that it is poor economy to purchase low-grade fertilizers.

It is also gratifying to note that the average per cent. of ammonia yielded by the cottonseed meals is a little higher than it was last year.

GRADES.

In the following table the number of acid phosphates, acid phosphates with potash, and complete fertilizers of each grade, according to guarantee, is placed side by side with the number found by analysis to belong to that grade, fertilizers having commercial values equal to those of schedule grades being classed in those grades:

	HIGH		STANDARD		LOW	
	Cl'md	Fo'nd	Cl'md	Fo'nd	Cl'md	Fo'nd
Complete fertilizers (325) ..	173	201	140	115	12	9
Acid phos. with potash (94) ..	52	89	42	4	0	1
Acid phosphates (87)	83	84	4	3	0	0
Total (506)	308	374	186	122	12	10

These results are due to the following changes in grades, ascertained by analysis:

	Low to High	Low to Standard	Standard to High	High to Standard	High to Low	Standard to Low	No Change
Complete fertilizers (325)	0	9	31	3	0	6	276
Acid phosphates (87)	0	0	4	3	0	0	80
Acid phosphates with potash (94)	0	0	37	0	0	1	56
Total (506)	0	9	72	6	0	7	412

This shows that out of 506 samples, 412 were of the grade claimed for them, 81 were of a higher grade and 13 of a lower grade than that claimed for them.

Last year out of 413 samples, 345 were of the grade claimed for them, 58 were of a higher grade and 10 of a lower grade than that claimed for them.

FARMERS' SAMPLES OF FERTILIZERS.

In addition to the samples of fertilizers collected by the Official Inspectors, there have been analyzed 48 samples for individual purchasers, as provided for in Section 1540 of the law respecting commercial fertilizers.

WATER.

There have been made this year 68 analyses of water from different parts of the State. Of these 47 were sanitary examinations, the rest complete or mineral water analyses.

CO-OPERATIVE WORK.

A considerable amount of work has been done by Messrs. McDonnell, Robertson and Henry in co-operation with the referee on nitrogen, and by Messrs. Robertson, Dickinson and Mitchell in co-operation with the referee on potash, for the Association of Official Agricultural Chemists.

DISTRIBUTION OF THE WORK.

Fertilizers were analyzed by Messrs. C. C. McDonnell, B. F. Robertson, W. E. Dickinson, and J. H. Mitchell; waters by Mr. D. H. Henry. Dr. R. N. Brackett has aided me in office duties and has attended, and made addresses at, a number of Farmers' Institutes.

Very respectfully,

M. B. HARDIN,
Chief Chemist.

REPORT OF THE HORTICULTURIST.

Clemson College, S. C., November 13, 1906.

Prof. J. N. Harper, Director, Clemson College, S. C.

Dear Sir: I respectfully submit a report of the progress of experiments being conducted in the Horticultural Division of the South Carolina Experiment Station for the year 1905-'06.

The past season has been very unfavorable for the maturity of all truck crops and various kinds of fruits on account of the excessive rainfall during the months of June, July, August and September. During these four months, we had 38.61 inches of rain, which is only a few inches short of our average yearly rainfall. Our varieties of peaches, plums, apples and grapes were greatly damaged by this continuous rain, making it almost impossible for us to spray the fruit in order to prevent injurious effects from fungus diseases. Under the circumstances, however, we did manage to mature a large number of varieties of the above named fruits and were able to make the necessary notes on the same for future publications.

Apples.—Our old experiment apple orchard produced a rather heavy crop of fruit, all of the early apples maturing well, but the fall and winter apples were damaged greatly by fungus diseases, especially bitter rot and apple scab. Many specimens of these varieties were put up in jars for the purpose of exhibition. The young orchard of seedling apples that we planted four years ago is in splendid condition, and we expect to get a fair crop of fruit from it the coming season. These apples all originated in the Piedmont section of this State, North Carolina and Georgia, and promise to prove of great value to our locality. Our experiments have shown that the Northern winter apples do not thrive well in this latitude, and in order to secure varieties that will prove valuable for commercial purposes, we will have to select varieties originating in the South, and therefore well adapted to our climate. Experiments have been conducted with the various methods of grafting the apple. We have used various lengths of scions, from two inches up to eighteen inches in length, and used stocks varying from three inches to twelve inches in length. After a careful examination of these trees, after two years' growth, we are unable to note any great difference either in the formation of roots or in the

general growth of the trees. It is generally supposed that the long scions are better than short ones, but our experiments do not confirm this opinion.

Peaches.—Our young peach orchard produced only a small amount of fruit the past season. The majority of the fruit was killed by heavy frosts the last of March. The Carmen, Elberta, Pallas and General Jackson were the only varieties that produced a fair crop of fruit. These varieties in some way escaped the frost. On account of the excessive rainfall, however, they suffered greatly from brown rot.

Plums.—Out of forty-five varieties of plums in bearing, all of the fruit on these trees were killed during the last of March by heavy frosts. Only four or five varieties produced a fair crop, but about half of this was destroyed by brown rot, the weather conditions being such we could not spray the fruit.

Cherries.—We were able to secure notes on ten varieties of cherries. These all matured perfectly and were all very fine quality and attractive in appearance. These trees are growing on a very stiff, clayey soil and have borne heavy crops for the past three years. We have a few cherries growing on sandy soil, but these have proved to be of no value. The cherry delights in stiff, clayey soil.

Pears.—Our young variety orchard of pears that was set out two years ago is well under way and during the next season should produce a few fruits.

Pecans.—We have sixty-five seedling pecans bearing fruit this season. Some of them have produced nuts of good quality and large size, but the majority of them have produced nuts so small that they would be worth very little on the market. These trees were all produced from nuts of large size and good quality. The best nuts *secured* will require about sixty-five to make a pound, while the smaller nuts will require from one hundred and seventy-five to one hundred and ninety-two to the pound. This shows plainly the advantage of either budding or grafting the trees in order that we may secure uniform nuts. These trees are now twelve years old and most of them have been in bearing for three years.

Raspberries and Blackberries.—For the past five years we have been growing a number of varieties of raspberries and

blackberries. These have borne a heavy crop every year. The best varieties of raspberries for our section are the following: The Turner, The Cuthbert, The Gregg and Shaffer's Colossal. The following varieties of blackberries have given best results: Early Harvest, Wilson's Early and Agawam.

Strawberries.—We have now growing in the horticultural grounds one hundred and fifty varieties of strawberries. We have made careful notes on these varieties from year to year and recommend the following as being best suited for our section of the State: Early, Excelsior; Medium, Lady Thompson; Late, Haverland. These three varieties will cover the entire fruiting season of the strawberry. They will give a continuous lot of fruit from the time the berries first begin to ripen until all are gone. We are conducting experiments with the various methods of culture, such as mulching the plants compared with clean culture, also using the following systems under clean culture: Single crown system, single hedge system, double hedge system and narrow matted rows. Our results of the past season show that the single crown and single hedge systems are superior to the others. These two systems produce an abundance of large berries. While the others produce more berries, they are smaller and it is more difficult to cultivate the plants.

Grapes.—Our variety vineyard this season gave very good results considering the season. We brought to maturity eighty-five varieties. It was necessary, however, to spray these continually in order to check the fungus disease. We have continued the experiment with various methods of pruning. The Four-arm Spur system and Four-arm Cane Renewal have given the best results.

Rotunda Folia Grapes.—We have been growing the Rotunda Folia type of grapes on trellises for the past ten years, and while this method is not usually practiced, we believe it to be far superior to the common arbor system. We have kept these vines pruned severely every year and, by actual weight, they have produced on an average of five bushels to the vine. The following varieties are to be recommended: Thomas, James and Flowers. The Thomas and James are both early varieties, but the Flowers comes in from two to three weeks later and remain

on the vine in good condition until the last of October. The scuppernong, which is grown very generally over the State, is one of the very best grapes of its type and is recognized as a favorite. The black varieties, however, are not as well known and as highly appreciated as they merit.

Hybrid Oranges.—Several years ago we received a number of hybrid oranges from the U. S. Department of Agriculture. These were planted in the horticultural grounds for trial. These trees are growing vigorously and as yet have not been injured by the severe winters, and from present prospects these varieties will fruit well in our State without danger of being injured by cold.

Musk Melons (Cantaloupes).—For the past three years we have been conducting variety experiments with cantaloupes, but every year they have been very much damaged by blight and it was necessary to spray continuously in order to check this disease. Four years ago we noticed a few vines that seemed comparatively free from this disease. We have been breeding from these comparatively immune vines, and we hope in the course of a few years to produce a first-class variety that we can grow without the necessity of spraying to check this disease. We are now growing these melons under glass and hope to gain one season in that way. The seed saved last summer were planted under glass in October. We hope to fruit these during the coming winter and save seed for planting next spring.

Celery.—For the past four years we have been conducting experiments with the methods of bleaching celery, also with the various methods of keeping celery during the winter. Our variety test shows the following varieties to be among the best: Giant Pascal, Shumatcher and Fin de Siecle. The results of our experiments will be ready for publishing in the course of a few weeks.

Onions.—The following experiments have been conducted with onions: Variety tests, methods of culture, with special reference to the distance of planting, time of planting, and the comparison of onions grown from sets with those grown from seed. Our best results have been obtained from seed sown during the middle of October. These plants were allowed to

remain in the open ground during the winter and matured during the following June. These onions were at least twice as large as those from seed sown in March. They also produced much larger onions than sets planted in March. In reference to the keeping quality, we found that the onions grown from seed would keep readily during the winter, while those grown from sets are very difficult to keep longer than the last of October.

Lettuce.—Our experiments with lettuce have been confined to variety tests and growing it under glass for winter use. We are now growing lettuce in cold frames and in the greenhouse, using bottom heat to force the plants to maturity. Lettuce will grow well out-of-doors in this section, with very slight protection, until the middle of December. After that time it should be protected with canvas or glass.

Cauliflower and Cabbage.—During the past three years we have conducted variety experiments with cabbage and cauliflower. Only a few of the varieties of cauliflower, however, have proved to be of much value. The Early Snowball is decidedly the best variety we have grown. The following varieties of cabbage are recommended: Charleston Wakefield for early, followed by Succession and All Seasons. These varieties are best for spring use. They also do well planted in summer, maturing during the months of October and November.

Eggplant.—This is one of our most difficult vegetables to grow on account of its being attacked in its early stage by fungus diseases and insects. By proper treatment, however, we can bring these plants to maturity. We have conducted experiments for the past three years with eggplants and our results are now ready for publication. The New York Purple and Black Beauty are decidedly the best varieties we have grown.

Tomatoes.—The following experiments have been conducted: Variety tests, methods of culture, pruning and training to stakes. We are also growing tomatoes in the greenhouse and have secured very good results. Our second crop of tomatoes under glass is now well under way, the plants blooming freely.

Irish Potatoes.—The following experiments have been conducted with Irish potatoes: Variety tests, different depths of planting, varying from three to twelve inches; methods of culture, including comparison of fall, winter and spring planting; methods of keeping potatoes during the winter. The past few years experiments with Irish potatoes show that the fall crop always keep much better than the first crop. Under ordinary conditions, the fall crop may be kept during the entire season, while the early crop decays badly during the summer months.

Respectfully yours. C. C. Newman,
Horticulturist.

REPORT OF THE ENTOMOLOGIST.

Clemson College, S. C., November 20, 1906.

Prof. J. N. Harper, Director, South Carolina Experiment Station.

Dear Sir: Although my study of the insects affecting the rice plant has not been completed, I am preparing a report on what has been done. This publication will contain information that not only relates to the commoner insect pests of the crop, but to many species hitherto not listed as injurious insects of the rice plant. On account of other duties, I have never reached the rice fields in time to study the insects affecting the crop during dry growth, and without observations during this period, the investigation cannot be finished. The problem of determining whether insects bear any relation to the distribution of "blast" or "rotten-neck" has been discontinued because of the resignation of the botanist with whom the work was originally planned. A continuance of this phase of the work is desirable and very important.

The progress of the investigation on the life history of the "stomach worm" (Strongylus contortus Rud) is gratifying in the main, though repeatedly interrupted by the presence of the parasite within the available animals for experimental purposes. These delays, however, have not been without value. Within another season, through continued co-operation with the Veterinary Division, I firmly believe that methods for freeing pastures and raising animals free of the parasite will be secured.

Beside the problems already mentioned, I have given considerable time to the collection of biological data on the insects that have been unusually common on the cotton and corn crops of the State.

In my correspondence, I have answered numerous questions relative to the habits and control of insects affecting fruits, vegetables, household goods and domestic animals. While I have stressed the importance of preventive measures, I have also pointed out the necessity of owning and using a spraying outfit, if losses from insects are to be minimized or prevented. If I am to judge of the value of these recommendations from the results that have been obtained, it is a most encouraging sign of the appreciation of economic entomology on the part of our constituency.

In conclusion, I may add that the work of this division has been greatly facilitated by the completion of the greenhouse, the north wing of which has been equipped for an insectary.

Yours respectfully, CHAS. E. CHAMBLISS,
Entomologist.

REPORT OF THE VETERINARIAN.

CLEMSON COLLEGE, S. C., November 20, 1906.

Prof. J. N. Harper, Director, S. C. Experiment Station.

Dear Sir: I have the honor to submit the following report of the work of the Division of Veterinary Science for the year ending June 30th, 1906:

The experiments in the treatment of "scours" in milk-fed calves were brought to a successful conclusion. A method of treatment was developed which is very efficacious, simple and easily applied, and which it is believed will prove of great practical value. A full report of this work was published in Bulletin No. 122.

The study of the disease caused by the stomach worm (strongylus contortus) in young cattle and sheep has been continued in co-operation with the Division of Entomology and Zoology. Certain obstacles have been met with that have delayed the work somewhat, chief among which is the difficulty in securing suitable experimental animals free from the para-

site; but, nevertheless, considerable progress has been made and we have every reason to believe that we will eventually be able to furnish information of some value. This parasite is more widespread than is generally realized and any knowledge that will assist in its control will be of great economical importance.

A series of experiments testing several methods of eradicating cattle ticks have been conducted on several farms in this County, in co-operation with the U. S. Department of Agriculture. This work was considerably disarranged by a delay in the transportation of some of the material, and was also further interfered with by the failure of some of the owners of the farms to observe the plans. In some respects, however, the results have been satisfactory and the work will be continued.

Very respectfully, LOUIS A. KLEIN,
Veterinarian.

REPORT OF THE DAIRY AND ANIMAL HUSBANDMAN.

CLEMSON COLLEGE, S. C., November 5, 1906.

Prof. J. N. Harper, Director, S. C. Experiment Station.

Dear Sir: I respectfully submit herewith a report of the work of the Division of Animal Husbandry and Dairying for the year ending June 30, 1906:

A thorough study has been made of the relative feeding value of wheat bran and cotton seed meal for milk production. The results of this study were published in Bulletin No. 117.

An investigation was also made of the markets for average dairy butter, which resulted in the publication of Bulletin No. 118, entitled, "Gathered Cream Plants." One or more of these plants is strongly recommended for this State.

The evident value of dairy farming to South Carolina has lead to the publication of a bulletin on this subject.

Another bulletin, covering an investigation of the water content and keeping quality of butter, is now ready to go to press.

A year ago this division undertook to determine the profitableness of swine raising in this State. Accordingly six grade brood sows and one pure bred Berkshire boar were procured

to serve as foundation stock. This foundation stock has yielded fifty-eight strong, vigorous offsprings, nearly every sow producing two litters of pigs during the year. The shotes from the first litter now average 160 lbs. per head. The feed consisted almost entirely of skim-milk (for young pigs), Dwarf Essex rape pasture, Bermuda grass pasture, sorghum and artichokes. The results have been highly satisfactory and will be published in bulletin form during the coming year.

A new line of work has been taken up by the division, namely, the breeding of horses. A pair each of pure bred German Coach and Standard bred mares has been purchased. This purchase and that of nine pure bred Jersey cows, together with the erection of a large piggery, have materially strengthened this division.

Respectfully submitted, JOHN MICHELS,
Dairy and Animal Husbandman.

REPORT OF THE ASSOCIATE AGRICULTURIST.

CLEMSON COLLEGE, S. C., November 20, 1906.

Prof. J. N. Harper, Director, S. C. Experiment Station, Clemson College, S. C.

Dear Sir: I respectfully submit the following report of the Agricultural Division of the Experiment Station:

The work of this division has been continued upon the lines reported November 28, 1905, and the scope extended and enlarged in an endeavor to secure such information for the farmers as they appear to be in need of.

This division had on exhibition in the institute car the following products grown on the experiment station grounds: Sixty varieties of cotton; twenty-four of wheat; forty-five of cowpeas; corn, oats, alfalfa, clover, vetch, etc. At the State Fair, the division exhibited the following: Sixty varieties of cotton; twenty-five of wheat; twenty of corn; forty-five varieties of cowpeas; eleven of sorghum; upland rice, chufas, Soy beans, alfalfa, crimson clover and Hairy vetch.

A large number of small packages of seed of cotton, corn and cowpeas have been distributed to farmers throughout the State, that the varieties succeeding best on the station grounds might

be tested in other localities. There have been more calls for such seed than the division was able to supply.

A number of crops have been grown experimentally, the most noteworthy being:

Cotton.—About eighty varieties for comparison to serve as a basis from which to select the better varieties for future work. The work of improvement in breeding cotton was continued and is to be enlarged as means and opportunity are afforded. A sufficient quantity of lint from one of the cross-bred varieties was submitted to the Textile Department that a mill test might be made. The very favorable results secured from this test emphasized the importance of further work to be done in co-operation between the Textile Department and Experiment Station. Since the Southern mills are producing a higher grade of cloth, and the demand for staple of special character is increasing, the work begun in this line indicates an opportunity for experimental work of peculiar interest and value.

Corn.—For several years a comprehensive series of tests have been conducted in co-operation with the U. S. Department of Agriculture. The main object of these tests is to determine the best variety of corn for this section and the best locality from which to procure seed. A bulletin setting forth the results as attained will be published as soon as the opportunity is afforded. The work of breeding a promising variety of corn by selection and cross pollination is under way and results attained so far are very promising. The results attained from careful selection and breeding of animals have been exceedingly profitable for many years, and as the facts controlling the proper selection and breeding of plants becomes better understood, these results will be of proportionally equal importance.

Wheat.—The results attained in the work with wheat for the past several years leads to the conclusion that the State should produce its own flour. By the use of good seed of suited varieties, fifteen to twenty bushels per acre have been secured, and by following the wheat with cowpeas from one to three tons of hay have been harvested. At prevailing prices there is more profit from an acre producing fifteen bushels of wheat and one and a half tons of cowpea hay than from an acre

producing a bale of cotton; and, further, the wheat and cowpeas leave the land in a better condition for the production of future crops.

Oats.—By practicing the open furrow system of planting the oat crop has become a comparatively safe one and may be grown more generally throughout the State than wheat, and probably with more profit to the farmers.

Cowpeas.—Work with this important hay and soil improvement plant has been continued with reference to the comparison of varieties for the several purposes for which the cowpea is grown, with reference to improvement of strains, to the feeding and fertilizing value and to curing the hay.

Sorghums.—A variety of sorghums, clovers and grasses have been under test. Efforts are being made to grow alfalfa on the ordinary uplands of the Piedmont section of the State. *Peanuts* and *chufas* have been found to produce abundantly, and with only ordinary cultivation and fertilization. These two crops, with several others admirably suited to hog raising, are highly recommended as hog foods to be gathered by the hogs themselves. Results obtained from *upland rice* this year indicate that it may be grown profitably both for grain and for hay or forage. A long list of varieties of imported *vetch* seed has been supplied the station by the Department of Agriculture and is under test. Many of these are imported from various foreign countries.

Respectfully submitted, C. L. NEWMAN.

REPORT OF THE BOTANIST AND BACTERIOLOGIST.

CLEMSON COLLEGE, S. C., November 17, 1906.

Prof. J. N. Harper, Director, S. C. Experiment Station.

Dear Sir: I herewith submit the report of the Division of Botany and Bacteriology for the year ending July 1st, 1906:

Correspondence.—This division has conducted a large amount of correspondence during the past year upon various topics, including cotton diseases; identification of grasses, weeds and other plants; fruit tree and plant diseases; sanitary conditions; graded school and nature study work. The sub-

jects of the correspondence as given above are in order of the number of letters received and answered.

Books.—Several new and valuable books have become available for use by the division during the last year. Among them are included new volumes of Engler & Prantl, The National Standard Dispensary and Schimper's Plant Geography, which are particularly valuable. Books relating to systematic botany are much needed by the division. Their purchase would avoid the reference of much correspondence and numerous specimens, especially grasses, to the U. S. Department of Agriculture for authentic determination.

Herbarium.—The herbarium has been entirely overhauled and rearranged between January the first and July the first. About five hundred specimens, representing the flora of the State and the eastern United States, were added during that period. The private herbarium of the botanist of over fifteen hundred mounted specimens has been placed on deposit in the herbarium. The herbarium in general was found to be in a very poor condition. Much of the work of previous botanists has been more or less wasted by the destructive work of insects, and every effort is being made to secure insect proof cases. A large number of botanical specimens representing the flora of South Carolina are ready for mounting as soon as cadet labor is available for that purpose. The collection of South Carolina grasses and other plants representing groups of more or less economic interest have been given particular care. The herbarium has been divided into three parts, one part representing the native flora of South Carolina; another part representing a general collection of the United States outside of South Carolina. In the third part, a record of all cultivated economic and ornamental plants is being made by means of well preserved specimens.

Investigation.—The investigations of this division under Prof. Metcalf culminated with the publication of his preliminary report on the rice blast, which appeared as a recent bulletin of the station. The work of the division under the present botanist, who has occupied the position only since January first, has been largely reorganization and observations in various parts of the State to determine what lines of work of the many

available, seem to be the most urgent. The result has been the mapping out of the following course of investigation: A study of the diseases of cotton, with particular reference to the influences of soil conditions upon their occurrence, and the relation of certain insects to subsequent diseased conditions. This will necessitate co-operation with the entomologist and possibly the agriculturist. Active investigation along this line will be begun early next season. Other points of interest along which more or less investigation is being carried on are upon the following subjects: The flora of the State, forest conditions and commercial and agricultural values of wild plants and fruits.

Respectfully,

H. D. HOUSE,
Botanist and Bacteriologist.

REPORT OF THE SECRETARY AND LIBRARIAN.

CLEMSON COLLEGE, S. C., November 23, 1906.

Prof. J. N. Harper, Director, S. C. Experiment Station.

Dear Sir: Responding to your request, I beg to submit the following report of some of the work as Secretary and Librarian of the Experiment Station for the period of the fiscal year, beginning July the 1st, 1905, and ending June 30th, 1906:

The agricultural public of South Carolina still continues to manifest an increasing interest in the publications of this Experiment Station. This has been clearly demonstrated by the fact that during the year just closed, 1,817 representative farmers applied to have their names enrolled on the permanent mailing list kept by this office for the distribution of bulletins.

The station has issued during the year nine bulletins, and one annual report. These contain in the aggregate 247 pages. Besides the analyses of commercial fertilizers, these bulletins represent intelligent discussions on quite a variety of subjects, such as: "Methods of Spraying Cucumbers and Melons," "A Comparison of Wheat Bran and Cotton Seed Meal for Milk Production," "Gathered Cream Plants," "Cotton Experiments," "Report on Rice Blast," "Calf Scours," and "Forage Crops."

The work of distributing the analyses of commercial fertilizers among the farmers of the State was begun in the month

of January. A leaflet of four pages, containing the analyses, was published at the college and mailed from this office once a week for twenty weeks, in editions of 12,000 copies each. These leaflets visited with weekly regularity 12,000 farms in this State, and the purpose of their publication was the protection of the farmers against the purchase of fraudulent fertilizers, by providing them with the records of the chemical analyses before the purchases were made.

The total number of bulletins issued from this station during the past fiscal year, including the fertilizer leaflets, amounted to 336,000 copies.

A complete file of all the bulletins from the various experiment stations in the United States, and some foreign States, is carefully kept, with a record of their subjects and numbers on the bulletin catalogue. These are subsequently put into convenient forms and bound into volumes.

It requires the exercise of constant and patient vigilance to keep the station mailing list free from errors. With this end in view, a careful examination of the list is rendered necessary after the distribution of each edition of the regular bulletins.

All of which is respectfully submitted,

JNO. N. HOOK,
Secretary and Librarian.

OF THE
UNIVERSITY OF ILLINOIS
28 APR 1915

Twentieth Annual Report

OF THE

SOUTH CAROLINA EXPERIMENT STATION

OF THE

Clemson Agricultural College

FOR THE YEAR ENDING
JUNE 30, 1907

COLUMBIA, S. C.
THE R. L. BRYAN CO., PRINTERS
1907

BOARD OF FERTILIZER CONTROL.

Hon. W. D. Evans. — Hon. G. Duncan Bellinger.
Hon. J. E. Wannamaker. — Hon. Alan Johnstone.
Hon. B. R. Tillman. — Hon. Robt. Aldrich.

H. M. Stackhouse, *Secretary.*

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Hon. J. E. Wannamaker. — Hon. M. L. Donaldson.
Hon. W. D. Evans. — Hon. Robt. Aldrich.

J. N. Hook, *Secretary.*

P. H. Mell, Ph. D., LL. D., *President of College.*

EXPERIMENT STATION STAFF.

J. N. Harper, B. S., M. Agr., *Director, Agriculture.*
M. B. Hardin, *Chief Chemist.*
C. C. Newman, *Horticulture.*
*C. E. Chambliss, M. S., *Entomology and Zoology.*
*L. A. Klein, V. W. D., *Veterinary Science.*
*John Michel, M. S. A., *Animal Husbandry and Dairying.*
C. L. Newman, M. S., *Agriculture.*
F. H. H. Calhoun, Ph. D., *Geology.*
*H. D. House, B. S., M. A., *Botany and Bacteriology.*
F. S. Shiver, Ph. G., *Chemistry.*
R. N. Brackett, Ph. D., *Chemistry.*
D. H. Henry, B. S., *Chemistry.*
John N. Hook, *Secretary and Librarian.*
B. F. Robertson, B. S., *Chemistry and Fertilizer Control.*
W. E. Dickinson, B. S., *Chemistry Assistant (Fertilizer Control)*
J. H. Mitchell, M. S., *Chemistry Assistant (Fertilzer Control).*
Thos. E. Keitt, B. S., *Chemistry Assistant (Fertilizer Control).*
J. M. Burgess, B. S., *Herdsman.*
W. D. Garrison, B. S., *Foreman of Station Farm.*
J. M. Jenkins, B. S., *Foreman Coast Land Experiment Station.*
Miss Helen Bradford, *Stenographer.*

Mail and telegraph: Clemson, S. C.
Freight and express: Calhoun, S. C.

The Bulletins of the Station are issued at irregular intervals, and are sent free to all citizens of the State who apply for them.

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*Resigned.

D. O. Nourse in place of John Michels, resigned.
H. W. Barre in place of H. D. House, resigned.
M. R. Powers in place of L. A. Klein, resigned.
A. F. Conradi in place of C. E. Chambliss, resigned.

LETTER OF TRANSMITTAL.

Clemson College, S. C., November 20, 1907.

Hon. M. F. Ansel, Governor of South Carolina.

Sir: I have the honor to submit herewith the Twentieth Annual Report of the South Carolina Agricultural Experiment Station, in accordance with the requirements of an Act of Congress, approved March 2, 1887, for the establishment of Agricultural Experiment Stations in connection with the colleges of the several States, organized under the provisions of an Act approved July 2, 1862. Respectfully submitted,

P. H. MELL, President.

REPORT.

Clemson College, S. C., November 26, 1907.

Dr. P. H. Mell, President, Clemson College, S. C.

Dear Sir: I have the honor to submit herewith the Twentieth Annual Report of the South Carolina Agricultural Experiment Station for the fiscal year ending June 30, 1907.

The work of the Station is constantly being enlarged, owing to increased funds and equipment. During the past year the Station has attained considerable growth. That the work of the Station is appreciated by the farmers is evidenced by the interest they have manifested in the results accomplished. Every day the mail brings a great number of letters from farmers requesting that their names be entered on the mailing list to receive Bulletins.

Most of the experiments that are now in progress are a continuation of those reported on in the last Annual Report. The nature of carefully planned experiments is such that it often requires years of work before any definite conclusion can be drawn, and it should be understood that only a limited number of experiments can be conducted at any one Station.

The principal investigations and experiments conducted during the year are as follows: A continuation of experiments in the production of starch from the sweet potato; experiments in the pruning of Rotundifolia grapes; test of methods of culture of a number of horticultural plants, such as strawberries, celery, eggplants, etc.; investigations as to the life history of the stomach worm. This disease is causing great loss to the live stock interest of the South. The number of calves and sheep that die each year of this disease within this State is considerable. The problem of determining whether insects distribute the disease of rice blast has been continued. This one disease is causing a loss of thousands of dollars to the rice industry of the State. Experiments testing various methods of eradicating cattle-ticks have been continued. The study of the disease caused by the stomach worm (Strongylus contortus) in calves and sheep has also been continued. A study of the effect of feeding large amounts of cotton-seed meal in connection with corn ensilage to dairy

cows has been made; also experiments in the crossing of German coach and stardard-bred horses; the Williamson method of corn culture; experiments in soil improvement; economic fertilizers for cotton; variety tests of cotton; improvement of cotton by crossing and selection; corn-breeding experiments; variety tests and improvement of wheat; investigations with forage crops, such as alfalfa, vetch, cowpeas, burr clover, etc., have been carried on.

During the year a number of the Station officers have assisted in college extension work.

The correspondence of the Station officers with farmers residing in the State amounted to more than seven thousand letters during the year. These were written in answer to letters from farmers seeking information on a great variety of subjects pertaining to agriculture.

The work done by the Station during the year in co-operation with the United States Department of Agriculture is as follows: Methods of eradicating the Texas fever tick; tests of fertilizers on rice lands; the use of lime and fertilizer in controlling the rice-blast disease; developing a sweet corn rich in sugar, for South Carolina; a study of the adaptability of fifty varieties of vetch for this region; the production of hemp seed in South Carolina.

Aside from this work with the government, the Station is growing cotton in thirty-five localities in the State in co-operation with farmers.

The Coast Land Experiment Station of Clemson College, located at Charleston, is under the general supervision of this office, and all of the experiments that were undertaken have been continued. Remarkable yields have been obtained from alfalfa, sorghum, cowpeas, Kaffir corn, teosinte, barley, rye, oats, wheat, beggar weed and a number of grasses. As much as six tons of cured alfalfa hay have been harvested from an acre. As much as sixty-nine bushels of corn per acre have been obtained following the Williamson plan, and this, too, when only a moderate application of commercial fertilizer was used. The usefulness of this substation will be greatly enlarged if it is moved to Summerville, as contemplated by the Board of Trustees.

Fuller details of this year's experiments will be found in the appended reports.

Thanking you for the interest you have always shown in this

work and the painstaking labor you have contributed to making it sucecssful, I remain,

Yours respectfully,

J. N. HARPER, Director.

SOUTH CAROLINA EXPERIMENT STATION.

in account with

THE UNITED STATES APPROPRIATION, 1906-1907.

Debtor.		Hatch Fund.	Adams. Fund.
To receipts from the Treasurer of the United States as per appropriations for fiscal year ended June 30, 1907, under Acts of Congress approved March 2, 1889 (Hatch Fund), and March 16, 1906 (Adams Fund)		$15,000 00	$7,000 00
Credit.	**Abstract.**		
By Salaries	1	$10,146 00	$2,400 00
Labor	2	1,274 86	817 28
Publications	3	1,137 40	
Postage and stationery	4	108 67	14 55
Freight and express	5	109 87	67 50
Heat, light, water and power	6	3 08	
Chemical supplies	7	432 73	12 77
Seeds, plants and sundry supplies	8	360 33	118 93
Fertilizers	9	59 85	157 23
Feeding stuffs	10	185 06	1,141 84
Library	11	84 34	
Tools, implements and machinery	12	322 60	174 59
Furniture and fixtures	13		
Scientific apparatus	14	140 65	294 04
Live stock	15	424 40	1,741 85
Traveling expenses	16	131 31	59 42
Contingent expenses	17	63 41	
Buildings and land	18	15 25	
Total		$15,000 00	$7,000 00

We, the undersigned, duly appointed Auditors of the Corporation, do hereby certify that we have examined the books and accounts of the South Carolina Experiment Station for the fiscal year ended June 30, 1907; that we have found the same well kept and classified as above; that the receipts for the year from the Treasurer of the United States are shown to have been $15,000.00, under the Act of Congress of March 2, 1887, and $7,000.00, under the Act of Congress of March 16, 1906, and the corresponding disbursements, $15,000.00 and $7,000.00; for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving balances of $..... and $.....

And we further certify that the expenditures have been solely for the purposes set forth in the Acts of Congress approved March 2, 1887, and March 16, 1906, and in accordance with the terms of said Acts, respectively.

(Signed) R. W. SIMPSON,
Chairman Finance Committee, Auditors.

Attest: P. H. E. SLOAN, Custodian.

SOUTH CAROLINA AGRICULTURAL EXPERIMENT STATION, 1906-1907.

(Supplementary Statement.)

(This supplementary statement, while not required by law, is desired as an aid in interpreting the account rendered for the United States appropriation. While it will be more useful if made in conformity with the schedule fixed for that appropriation, if this is not practicable such a summary of receipts and expenditures from the sources indicated below as can be conveniently prepared from the books of the Station may be substituted. Whenever practicable, it should be for the fiscal year ended June 30.)

Debtor.

To Receipts from other Sources than the United States of the Year Ended.

Balance July 1, 1906	$1,969 19
Received to July, 1907	1,402 53
Total	$3,371 72

Credit.

By Salaries	$766 63	
Labor	186 41	
Publications	183 92	
Postage and stationery		
Freight and express	12 78	
Heat, light, water and power		
Chemical supplies		
Seeds, plants and sundry supplies	129 67	
Fertilizers	66 66	
Feeding stuffs	110 00	
Library		
Tools, implements and machinery	48 35	
Furniture and fixtures		
Scientific apparatus		
Live stock		
Traveling expenses	239 29	$1,743 71
Balance		$1,628 01

REPORT OF CHEMIST.

Clemson College, S. C., November 8, 1907.

Prof. J. N. Harper, Director, S. C. Experiment Station.

Sir: I respectfully submit the following report of the Chemical Department of the Station for the year ending June 30, 1907. The work on the production of starch from sweet potatoes has been continued. In the summer of 1906 the experimental starch factory was enlarged and additional machinery was ordered. Delays occurred in securing some of the machinery and it was found impossible to commence work before the 5th of December. Experiments were made with three varieties of sweet potatoes. The average yield was nearly nine pounds of starch per bushel of potatoes. The starch was separated into two grades, but trials at one of the cotton mills in the State showed that there was practically no difference in the results obtained with the two grades. All of the starch tested at the mills was pronounced to be of superior quality. The pulp left as a by-product in the manufacture of the starch weighed, when dried, at from 50 to 60 degrees C., about five or six pounds per bushel of potatoes. This pulp will doubtless make a good, though, of course, not a high-grade, cattle food.

Mr. C. C. McDonnell, who had immediate charge of the manufacture of the starch and of the analysis of the potatoes, starch and waste pulp, resigned his position as Assistant Chemist March 19, 1907, to accept a place in the Bureau of Chemistry, United States Department of Agriculture. The analytical work was, therefore, turned over to Mr. T. E. Keitt, whose results will be incorporated in the Bulletin to be issued on the subject.

The other work of the department has been in co-operation with the Agricultural Department. In connection with an investigation by the Director of the Station, Mr. F. S. Shiver has analyzed ten samples of soils, determining nitrogen, phosphoric acid and potash. The phosphoric acid and potash were determined in solutions made, respectively, by the use of hydrochloric acid, specific gravity 1.115, and one-fifth normal nitric acid.

For the Division of Dairying he has analyzed a sample of wheat middlings and a sample of rice meal. In addition to this work, he has analyzed samples of three soils for a citizen of the State.

He has also spent a considerable amount of time in co-opera-

tion with the Professor of Dairying, in the preparation of Bulletin 125, of this Station.

ANALYSES OF COMMERCIAL FERTILIZERS.

Following is a report of the work on commercial fertilizers done for the Board of Fertilizer Control:

	1905-6.	1906-7
Official samples	655	743
Farmers' samples	48	43
OFFICIAL SAMPLES.	703	786

The analyses are given in full in Bulletin No. 126.

CLASSIFICATION.	1906.	1907.
Complete fertilizers	325	390
Acid phosphates	87	111
Acid phosphates with potash	94	72
Cotton seed meals	79	99
Kainit	29	30
Nitrate of soda	19	20
Muriate of potash	13	13
Sulphate of potash	2	1
Nitrate of soda with potash	2	3
Tankage	2	0
Dried blood	1	1
Miscellaneous	2	3
DEFICIENT SAMPLES.	655	743

Of the 743 samples reported, 74 fell below the commercial value, based upon guarantee, and of these 25 fell 3 per cent. or more below that value. In addition to these there were 153 samples below the guarantee in one or more constituents, the deficiency, however, being made up by an excess of the other constituents. They are as follows:

In available phosphoric acid	31
In ammonia and potash	7
In ammonia	81
In potash	34
Total	153

The extent to which they fell below guarantee is shown in the following table:

	Below Guarantee—Per Cent.				
	0–.10	.10–.25	.25–.50	.50–1.00	1.00 and over
In Available Phosphoric Acid.	3	10	8	8	2
In Ammonia	29	25	26	8	0
In Potash	7	16	7	9	2
Total	39	51	41	25	4

AVERAGE OF ANALYSES

	1906 Per Cent.		1907 Per Cent.	
	Found	Guaranteed	Found	Guaranteed
Acid Phosphates				
Soluble Phosphoric Acid	11.71	.....	11.17	.....
Reverted Phosphoric Acid	3.24	.....	3.78	.....
Available Phosphoric Acid	14.95	14.03	14.95	14.10
Insoluble Phosphoric Acid	.60	.....	.66	.....
Total	15.55	.....	15.61	.....
Acid Phosphates with Potash				
Soluble Phosphoric Acid	7.80	.....	7.62	.....
Reverted Phosphoric Acid	3.17	.....	3.14	.....
Available Phosphoric Acid	10.97	9.97	10.76	9.91
Insoluble Phosphoric Acid	.63	.....	.72	.....
Total	11.60	.....	11.48	.....
Potash, soluble in water	3.30	3.15	3.21	3.11
Complete Fertilizers				
Soluble Phosphoric Acid	6.54	.....	6.27	.....
Reverted Phosphoric Acid	2.80	.....	2.64	.....
Available Phosphoric Acid	9.34	8.21	8.91	7.92
Insoluble Phosphoric Acid	1.39	.....	1.45	.....
Total	10.73	.....	10.36	.....
Ammonia	3.26	3.23	3.29	3.24
Potash, soluble in water	2.98	2.74	3.29	2 71
Cotton Seed Meals				
Available Phosphoric Acid	2.42	1.47	2.68	1.48
Ammonia	7.51	7.11	7.32	6.91
Potash, soluble in water	1.57	1.00	1.69	1.00
Kainits				
Potash, soluble in water	12.83	12.00	12.78	12.00
Muriate of Potash				
Potash, soluble in water	50.05	48.50	51.52	48.75
Sulphate of Potash				
Potash, soluble in water	49.57	48.00	48.20	48.00
Nitrate of Soda				
Ammonia (equivalent)	18.67	18.21	18.49	18.26

Only one sample of Sea Island meal was analyzed this year. It yielded 5.06 per cent. of ammonia, 5 per cent. being guaranteed. The following table shows the yearly averages of fertilizer analyses from the time the Board of Trustees of the College took charge of the Station work, down to the present time:

YEARLY AVERAGES OF ANALYSES FROM 1891 TO 1907, INCLUSIVE

SEASON	Acid Phosphates		Acid Phosphates with Potash			Complete Fertilizers				Cotton Seed Meals				Kainits		Muriate of Potash		Nitrate of Soda	
	Number of Samples	Available Phosphoric Acid Per Cent.	Number of Samples	Available Phosphoric Acid Per Cent.	Potash, Soluble in Water Per Cent.	Number of Samples	Available Phosphoric Acid Per Cent.	Ammonia Per Cent.	Potash, Soluble in Water Per Cent.	Number of Samples	Available Phosphoric Acid Per Cent.	Ammonia Per Cent.	Potash, Soluble in Water Per Cent.	Number of Samples	Potash Per Cent.	Number of Samples	Potash Per Cent.	Number of Samples	Ammonia Per Cent.
1890-1	49	13.02	19	11.84	1.65	173	9.34	2.68	1.96	30	.....	8.37	.....	21	12.75	1	51.96	1	19.22
1891-2	29	12.92	16	11.50	1.49	112	8.83	2.80	1.95	25	.....	8.21	.....	18	12.51	....	.....	1	18.63
1892-3	48	12.32	26	11.63	1.22	150	9.00	2.91	1.65	20	2.62	8.40	1.32	20	12.05	....	.....	...	.....
1893-4	46	13.24	22	12.01	1.51	132	9.27	2.53	1.79	22	2.45	8.64	1.69	17	12.37	....	.....	....	.....
1894-5	46	13.55	15	12.09	1.66	87	9.42	2.55	1.77	33	2.58	8.19	1.66	19	12.30	....	.....	....	.....
1895-6	42	13.43	26	11.99	1.39	115	9.31	2.64	1.86	34	2.57	8.45	1.61	16	12.45	....	.....	....	.....
1896-7	59	13.61	34	12.06	1.61	117	9.55	2.70	1.91	40	2.53	8.69	1.64	22	12.44	....	.....	....	.....
1897-8	63	13.67	50	11.54	2.06	141	9.15	2.70	1.93	39	2.37	8.39	1.58	20	12 68	....	.....	1	19.23
1898-9	73	13.74	68	11.77	1.99	134	9.32	2.73	2.21	40	2.76	8.25	1.75	14	12.78	2	51.93	2	18.96
1899-1900	73	13.58	63	11.58	2.00	124	9.50	2.73	2.13	52	2.27	8.73	1.63	8	12.73	4	50.95	3	19.01
1900-1	56	14.00	55	11.49	2.65	139	9.40	2.87	2.47	60	2.38	8.55	1.54	12	12.61	2	48.92	3	18.96
1901-2	45	14.11	51	11.09	2.55	141	9.39	2.84	2.34	49	2.57	7.93	1.63	16	12.85	4	50.54	3	19.03
1902-3	51	13.74	55	10.94	2.65	139	9.02	2.69	2.42	69	2.27	8.08	1.48	15	12.92	2	50.25	2	19.15
1903-4	59	14 32	75	11.12	2.81	180	9.12	2.99	2.90	57	2.28	7.92	1.54	11	12.94	7	49.79	6	18.87
1904-5	81	14.81	82	10.70	3.07	250	9.19	3.12	2.90	62	2.41	7.42	1.54	26	12.54	6	50.49	7	18.73
1905-6	87	14.95	94	10.97	3.30	375	9.34	3.26	2.98	71	2.42	7.51	1.57	29	12.83	13	50.05	19	18.67
1906-7	111	14.95	72	10 76	3.21	390	8.91	3.29	3.29	99	2.68	7.32	1.69	30	12.78	13	51.52	20	18.49

In this table, as in the preceding ones, the ammonia yielded by the nitrogen in fertilizers is given instead of the nitrogen itself, as in the trade, goods are still bought and sold on the ammonia basis. The per cent. of nitrogen is readily calculated, as fourteen-seventeenths of the ammonia is practically the weight of the nitrogen it contains.

GRADES.

In the following table the number of acid phosphates, acid phosphates with potash, and complete fertilizers of each grade, according to guarantee, is placed side by side with the number found by analysis to belong to that grade, fertilizers having commercial values equal to those of schedule grades being classed in those grades:

	High		Standard		Low	
	Claimed	Found	Claimed	Found	Claimed	Found
Complete Fertilizers, 390.....	207	249	167	137	16	4
Acid Phosphates with Potash, 72	37	63	35	9	0	0
Acid Phosphates, 111.....	105	103	6	8	0	0
Total, 573	349	415	208	154	16	4

These results are due to the following changes in grade ascertained by analyses:

	Low to High	Low to Standard	Standard to High	High to Standard	High to Low	Standard to Low	No Change
Complete Fertilizers, 390.....	2	12	41	1	0	2	332
Acid Phosphates with Potash, 72..	0	0	26	0	0	0	46
Acid Phosphates, 111..... .	0	0	4	6	0	0	101
Total, 573.....	2	12	71	7	0	2	479

This shows that out of 573 samples, 479 were of the grade claimed for them, 85 were of a higher grade and 9 of a lower grade than that claimed for them. Last year, out of 506 samples,

412 were of the grade claimed for them, 81 were of a higher grade and 13 of a lower grade than that claimed for them.

FARMERS' SAMPLES OF FERTILIZERS.

In addition to the samples of fertilizers collected by the official inspectors, there have been analyzed this year 43 samples for individual purchasers, as provided for in section 1540 of the law respecting commercial fertilizers.

WATER.

There have been made this year 89 analyses of water from different parts of the State. Of these 70 were sanitary examinations; the rest, mineral water analyses.

CO-OPERATIVE WORK.

Mr. J. H. Mitchell has made determinations, by different methods, of the iron and aluminium oxides in phosphate rock, the work being done in co-operation with the referee on phosphoric acid, for the Association of Official Agricultural Chemists.

DISTRIBUTION OF THE WORK.

Fertilizers were analyzed by Messrs. C. C. McDonnell, B. F. Robertson, W. E. Dickinson, J. H. Mitchell and T. E. Keitt; waters, by Mr. D. H. Henry. Dr. Brackett has aided me in office duties and has made addresses at seventeen Farmers' Institutes. Very respectfully,

W. B. HARDIN,
Chief Chemist.

REPORT OF HORTICULTURIST.

Clemson College, November 2, 1907.

Prof. J. N. Harper, Director South Carolina Experiment Station.

Dear Sir: I respectfully submit a report of the progress of the experiments conducted in the Horticultural Division of the South Carolina Experiment Station for the year ended June 30, 1907.

Our prospects for a good fruit crop during the last season were very good until late in April, when the majority of the fruit was killed by a severe freeze. This, of course, prevented our taking the usual notes on the various varieties of fruits we have under cultivation in the horticultural grounds.

Apples.—Our old apple orchard has been greatly improved during the past season by severe pruning and continuous spraying during the summer. We have changed the method of culture, adopting the sod-mulch method instead of the clean-culture method that we had been following for the past seven or eight years. The results of our experiments with the sod-mulch emthod have been so favorable that we decided to adopt this method in our general variety orchard. A great many of the Northern varieties of apples that we have in the old orchard are not suited to this section of the country, but we have decided to allow these trees to remain in order to compare them with other new varieties that are being introduced from time to time.

Our seedling-apple orchard will come into bearing during the next season, and we hope to secure fruit from most of the varieties. Some of the seedlings we have collected have attracted a good deal of attention and, we believe, will be very valuable in this section of the State. The Rabun apple has attracted more attention than any of the other varieties that we have introduced. This apple appears in the list of promising new fruits in the Year Book of the Department of Agriculture, 1906.

Peaches.—The entire crop of peaches was destroyed this spring by the late freeze in April, and we had no opportunity of making further comparisons of the various varieties. We have planted a great many new varieties that have been introduced in the last few years, and these are coming on nicely and will be bearing in another year. Our location here is not favorable to peaches, on account of their being killed by the late frosts of

spring. During the past ten years we have had only two full crops of peaches.

Plums.—The plums were also killed in the spring by the freeze. The trees are in good condition and capable of bearing a heavy crop of fruit next year. We have planted a lot of new varieties that have been introduced in the last few years. These trees are now three years old and should bear their first fruit next spring. The plums are subject to the brown rot, and in order to bring them to maturity it will be necessary for us to spray continuously during the growing season.

Cherries.—The majority of the varieties of cherries were also killed by the freeze in the spring. Some of the varieties, however, matured some fruit, and we were able to secure satisfactory notes on them. The cherry does not thrive well here, except on a clayey soil. The trees soon become weak and sickly if grown on a sandy soil. The cherry is subject to a disease which attacks the leaves during the spring and summer and causes them to drop to the ground about the first of August. The trees are then practically dormant for a few weeks, and as soon as the rains and warm weather of fall come, the trees start to growing freely, and the bloom-buds open in the fall instead of the following spring. They are, of course, destroyed by frost and the next year's crop is considerably lessened. We have found that by spraying the trees freely with Bordeaux Mixture they will retain their leaves and will not bloom out in the fall. It is not necessary to spray the cherry in order to prevent the fruit from rotting, but only to keep the leaves in a healthy condition until frost.

Pears.—Our young pear orchard is progressing satisfactorily. Very little blight appeared during the past season, and the trees are now large enough to bloom and we hope to get some fruit the coming season.

The old pear orchard was practically destroyed by blight three or four years ago, and this young variety orchard was set out soon after the old trees were dug up. We are experimenting with different methods of culture, in order to see what effect this will have on the blight. Our past records show that the pear trees kept in a vigorous growing condition suffered more from blight than trees that were in a less vigorous condition.

Pecans.—In our last report we mentioned the fact that sixty-five seedling pecan trees had produced a good crop of nuts. This season the fruit on these trees was killed by the spring frost. Some of these trees have been in bearing for four years, and this

is the first time they have ever been injured by cold. The following table will show the variation in the size of the seedling nuts. This will emphasize the importance of planting either budded or grafted trees rather than the seedlings. We have planted most of the improved varieties of pecans, and hope to bring them into bearing in a few years.

VARIETY	No. of Nuts per pound	VARIETY	No. of Nuts per pound
Seedling No. 1	75	Seedling No. 32	54
Seedling No. 2	144	Seedling No. 33	73
Seedling No. 3	96	Seedling No. 34	90
Seedling No. 4	96	Seedling No. 35	65
Seedling No. 5	80	Seedling No. 36	136
Seedling No. 6	110	Seedling No. 37	112
Seedling No. 7	96	Seedling No. 38	98
Seedling No. 8	74	Seedling No. 39	120
Seedling No. 9	80	Seedling No. 40	128
Seedling No. 10	64	Seedling No. 41	54
Seedling No. 11	128	Seedling No. 42	134
Seedling No. 12	80	Seedling No. 43	77
Seedling No. 13	74	Seedling No. 44	150
Seedling No. 14	85	Seedling No. 45	72
Seedling No. 15	75	Seedilng No. 46	80
Seedling No. 16	77	Seedling No. 47	107
Seedling No. 17	128	Seedling No. 48	128
Seedling No. 18	105	Seedling No. 49	90
Seedling No. 19	65	Seedling No. 50	94
Seedling No. 20	91	Seedling No. 51	88
Seedling No. 21	94	Seedling No. 52	85
Seedling No. 22	73	Seedling No. 53	96
Seedling No. 23	85	Seedling No. 54	146
Seedling No. 24	140	Seedling No. 55	96
Seedling No. 25	146	Seedling No. 56	77
Seedling No. 26	70	Seedling No. 57	192
Seedling No. 27	51	Seedling No. 58	133
Seedling No. 28	70	Seedling No. 59	64
Seedling No. 29	107	Seedling No. 60	85
Seedling No. 30	96	Seedling No. 61	70
Seedling No. 31	97		

Strawberries.—A large percentage of the strawberries were also killed by the frosts in the late spring. This, of course, prevented our making complete notes on the various varieties. We

have now more than one hundred and fifty varieties of strawberries in our experimental plots and will plant a few newer varieties this fall. We have carefully tested the various methods of growing strawberries, using the single-crown system, the single-hedge system, the double-hedge system, and the matted-row system. The single-crown system has in every case produced the finest berries, and the yield has been almost as large as any of the others. The single-hedge system ranks next to the single-crown method. The advantage of the single-crown system is, that the berries may be easily gathered, more easily cultivated, and average larger in size than when grown by other methods.

Grapes.—Our grapes were also killed by the frost in April. Out of more than a hundred varieties, only three or four produced fruit. We have continued our experiments with the different methods of pruning and training the grape. The four-arm spur system and the four-arm cane renewal have proved to be two of the best methods we have tested.

Rotundifolia Grapes.—The rotundifolia grapes were not injured by the frost, on account of their blooming one month later than the bunch grapes. This type of grapes has never been injured by the cold, while the other grapes have been injured a number of times during the past few years.

Grapes of this type are not often pruned, in the South, because it is generally supposed that pruning will injure the vine. If the vines are pruned during the months of October and November, there will be no injurious effects, but if they are cut later in the season, they will bleed badly and will be seriously injured, if not destroyed. If the pruning is delayed until after December, there will always be more or less injury to the vine, caused by the loss of sap in the spring. After the vines have made a growth of from five to six inches, in the spring, small vines may be cut without causing serious injury, but the large vines will bleed badly even at this season. Vines cut in the late winter will not bleed until the weather begins to turn warm, but will then bleed freely. They will cease to bleed if the weather turns cool again, only to bled more freely as the spring advances. A vine that has been pruned too late in the season will be so weakened by the loss of sap that it will be a week or ten days later in starting to grow than vines pruned in the early fall. To demonstrate the evil effect of late pruning, two vines growing side by side were pruned, one the 15th of November and the other

the 15th of February. The vine pruned in November did not bleed at all as the spring advanced, and produced a wonderful crop of fine fruit. The vine pruned in February began to bleed as soon as the weather turned warm—slowly at first, but bleeding more freely as spring advanced. Drops of sap could be seen steadily dripping from the end of each vine that had been cut. The vine pruned in Feburary was ten days later in putting out leaves than the one pruned in November. The growth was very feeble and it set very little fruit, most of the canes dying during the summer. To form some idea as to the amount of sap that would flow from a vine that had been pruned too late in the season, a third vine was pruned in November, and on the 20th of March, one cane, one-half inch in diameter, was cut on the same vine and a rubber tube fastened over it so as to conduct the sap to a large glass jug, the mouth being closed with a cork through which a rubber tube passed. The vine began to bleed freely from the cane cut March 20, but canes cut in November did not bleed at all. A careful record was kept of the sap collected, and in four weeks from the time the cane began to bleed, twenty-three pounds of sap had been collected from this one cane. The loss of sap through this cane affected the entire vine, and its growth was checked considerably. (See Bulletin No. 132.)

Hybrid Oranges.—We stated in our last annual report that the hybrid oranges sent out by the United States Department of Agriculture were doing well. The last winter, however, proved too severe for these plants. We had two dozen of these trees well under way, and all were killed, except one. They stood the winter fairly well, but when spring advanced they started to grow freely and were killed by the late spring freeze, which destroyed practically all of our other fruits.

Muskmelons (Canteloupes).—We have continued our experiments in growing varieties of muskmelons, and also our breeding experiments. We are trying to secure a variety that is free from the common wilt disease so destructive to the melons in this State. It will take several years to complete this experiment, but we have it very well under way and are making fair progress.

Celery.—We have conducted experiments with the various methods of blanching celery, and also with the various methods of keeping the celery during the winter. Our variety test put Giant Pascal, Schumatcher and Fin de Seicle in the lead.

Onions.—We have also continued our experiments with onions. The past season we matured thirty-five varieties. These seeds

were planted on the 24th of September. They remained unprotected all during the winter and were not injured by the cold. In the spring they grew off vigorously and matured their bulbs early in June. The results of this experiment show that the seed planted in the fall will produce larger and better onions than sets planted at the same time. Seeds planted in the spring produced onions only half as large as seeds planted in the fall. We also find that the onions produced from seeds will keep much better than onions grown from sets. We recommend the following varieties for general planting: Prizetaker, Southport Globe, and Yellow Danvers.

Tomatoes.—We continued our experiments with the various methods of pruning and training tomatoes, growing them under glass, and also in the field. The results of our experiments under glass proved very satisfactory. Single plants produced as much as eight pounds of perfect fruit. We found it necessary to pollenize the blossoms by hand. Our experiments in the field this season were very unsatisfactory, on account of the blossom-end rot, which destroyed practically three-fourths of the crop. Our spraying experiments to check this disease were not encouraging. We will contintue the experiments another season, using different fungicides and applying them more frequently. The continuous rains during the ripening period of the tomato made it very difficult for us to apply these solutions at the proper time, and frequently they would be washed off in a few hours after having been applied. We could see no difference in this disease on the various varieties, as it appeared to attack all of them. We had in our experiment plot forty-five varieties of tomatoes, but on account of this disease, were unable to get satisfactory notes.

Irish Potatoes.—Our experiments with both the spring and fall crop of Irish potatoes were very satisfactory. We tested thirty-four varieties in the spring and forty-six varieties in the fall. The yield of the fall crop was equally as good as that of the spring crop in nearly every case, and in many varieties it greatly exceeded that of the spring crop. Our principal trouble was in getting a perfect stand in the fall. Our best results were obtained where the tubers were sprouted before planting. This was done by covering the potatoes by heavy mulch as soon as they were dug, in June, and allowing them to remain there until they sprouted. Then they were taken up and planted. Where this method was not pursued we did not secure more than about half a stand. We have not been able to keep our spring crop

potatoes during the winter, but find little trouble in keeping the fall crop. They may be put in barrels and stored in a cellar, and will remain there in good condition during the entire winter. Our results in spraying the Irish potato to prevent diseases of the leaf were very satisfactory. In some cases the yield was increased fifty per cent. by three applications of Bordeaux Mixture. Our experiments along this line will be continued another season.

We have also continued experiments with varieties of cabbage, cauliflower and egg-plants.

Respectfully submitted.

C. C. NEWMAN,
Horticulturist.

REPORT OF PROFESSOR OF AGRICULTURE.

Clemson College, S. C., November 23, 1907.

Prof. J. N. Harper, Director South Carolina Experiment Station, Clemson College, S. C.

Dear Sir: I respectfully submit the following report of the Agricultural Division of the Experiment Station:

The work of this division, as reported in previous reports, has been continued and enlarged, and additional problems taken up for investigation. Increased facilities for experimental purposes afford opportunities for more extensive and satisfactory work than has been possible in the past.

This division prepared comprehensive exhibits for institute work in July and August, and for the State Fair, recently held at Columbia. These exhibits were for educational purposes rather than mere show. Such means of taking the work of the Experiment Station to the farmer have been, as is shown in testimonials from the farmer, productive of good, and their continuance is desirable.

Material for five bulletins is now ready—embracing cotton, cowpeas, wheat, varieties of corn, and the Williamson method of corn culture. As time is afforded, these will be prepared for publication.

The correspondence of the Agricultural Division has steadily increased through the past two years. The letters received from the farmers of the State are almost entirely letters of inquiry and, collectively considered, furnish a good index to the information sought by the farmer, and, at the same time, bring the farmer and the Experiment Station in close touch. In planning the work of this division, due consideration is given these inquiries, since the object of the Experiment Station is, primarily, for the benefit of the farmer and his vocation.

The lines of work to which greater attention is being paid are:

Cotton.—The number of varieties under test has been reduced from about eighty to forty-one; those under test in the past giving little promise having been discarded, and only the better varieties remained for further test. This work embraces the determination of the comparative yields of the various varieties, the grading of the lint, selection of seed from best stalks, deter-

mination of percentage of lint, number of bolls to the pound, and effect of roller and saw gin upon market value of staple. Cotton being the most important product of the State, greater attention is being given this than any other crop. The varieties giving greatest promise are being bred by careful selection and their improvement being carried on by the stalk-row plan. Between three hundred and four hundred hybrids were produced the past summer, and their future development is to be carried on for an indefinite number of years. In the selection of the parents for the production of these hybrids, prolificness, length and strength of staple, earliness and resistance to disease are the main qualities so far considered in the production of the new hybrids just begun. The hybrids found here when I assumed my duties with the Experiment Station are being further developed by individual stalk selection and stalk-row tests, with very gratifying results. The variety originated by the Experiment Station, and known as Blue Ribbon, has been distributed in various localities throughout the State, and has, as a rule, been well received by the farmers. When offered on a discriminating market, lint from this variety has brought from five to ten cents per pound premium, while the yield per acre ranks it among the most prolific in many localities. The further improvement of this variety was undertaken on a larger scale this year, and selections were made from the best of several thousand stalks, for future work. I am convinced that the South Carolina Experiment Station can emphasize no work of importance equal to improvement of varieties, or strains, of cotton adapted to the various soils of the State. The superiority of certain extra staple or upland long-staple cotton is attracting favorable attention throughout the cotton states, and particularly in South Carolina. The people of the State are eager for reliable information concerning this class of cotton, and the Agricultural Division is now prepared to take up the work on an enlarged scale, if time and opportunity are afforded.

Corn.—The work with corn, as outlined in my last report, is being continued and enlarged, data having been secured for the publication of results when the time is afforded for the preparation of a bulletin. Extensive trials of the Williamson plan have been made, and are to be written up as soon as possible. Interesting results have been attained from efforts to determine the relative ability of bottom and top ears to reproduce, and the tests are to be repeated and enlarged upon in the future. The effects of pollen from barren stalks are under investigation. Deeper

and more thorough preparation of the soil, for both cotton and corn, has given yields equal to those secured from the use of fertilizers on indifferently prepared soils. The good effects of the use of improved farm implements have been most marked. The modern disc plows and weeders have proven especially satisfactory, and their more general use is encouraging.

Wheat.—The work reported in the past has been continued with wheat, and extensive variety improvement will be taken up when the opportunity is afforded. The profitable culture of wheat, in association with judicious rotation and deep plowing, is amply demonstrated.

Alfalfa.—The alfalfa trials have been continued and the area devoted to this crop enlarged. Twenty-odd regional strains have been secured through the United States Department of Agriculture, and are under trial.

Burr Clover.—Two species of this legume are under trial.

Cowpeas.—The experiments with cowpeas have been continued and material is on hand for a bulletin covering results obtained.

Vetch.—A large number of vetch varieties were secured from the United States Department of Agriculture. Many of these gave fair promise the past season, and the best of the number are now under trial, the present crop being grown from seed produced on the Station grounds.

Broom Corn.—Several varieties of broom corn were grown the past season, and the results strongly indicate that this may be made a profitable crop. The work will be continued and the results published.

Peanuts, chufas, and upland rice, grasses, and miscellaneous legumes have been under test.

Respectfully submitted.

C. L. NEWMAN,
Associate Professor of Agriculture.

REPORT OF GEOLOGIST.

Prof. J. N. Harper, Director Experiment Station, Clemson College, S. C.

Dear Sir: During the year 1906-1907 I engaged in the following work in the Experiment Station:

Sixty minerals, sent to the Geological Department by residents of the State, were examined, and a report concerning their value was made in each case, to the sender.

A record of the temperature, pressure and humidity throughout the school year at Clemson College was recorded.

One hundred photographs were taken by me for various members of the Experiment Station staff.

Photomicrographics of starch grains were made for the Department of Chemistry.

In addition to this work, an investigation of the geological relation of soils was carried on in co-operation with the Division of Agronomy. Yours truly, FRED H. H. CALHOUN,

Geologist.

REPORT OF BOTANIST AND BACTERIOLOGIST

Clemson College, S. C., November 15, 1907.

Prof. J. N. Harper, Director South Carolina Experiment Station, Clemson College.

Dear Sir: I have the honor to submit the following report, which, of course, covers a period in which my predecessor acted as botanist and bacteriologist, and is, of necessity, based on work left by him and on the period of my incumbency—September 10, 1907, to date.

During the past year, the Botanist has devoted his attention to improving and enlarging the herbarium and to making some study of forest problems and of diseases of cotton. As far as I can ascertain, however, no very serious effort has been made to investigate any definite problem. This was probably due to the large amount of teaching required, and shows that no very great aomunt of investigation work can be expected from this division without the aid of an assistant.

Herbarium.—The herbarium has been rearranged and part of it placed in insect- and dust-proof cases. A number of specimens have been added during the year. Owing to lack of necessary literature on systematic botany, however, a great many of these were entered without their specific names. This greatly lessens their value as herbarium specimens. Although this side of the work has been emphasized, the herbarium is far from complete, and we are still very much in need of a complete collection of plants of economic importance found in this State. The appropriation for the herbarium has been discontinued, however; so this work must be dropped for the present.

Forestry.—The study of forest problems culminated in the publication of Bulletin No. 129, entitled "Improvement of the Wood Lot." Forestry work is exceedingly important to us at this time, however, and there are still numerous problems in this connection which need attention.

In reference to future work, I would like to call your attention to the growing demand for more accurate and more definite knowledge concerning the various plant diseases prevalent in the State. With the promise of a student assistant to help with culture work in this connection, however, this phase of the work is encouraging. The anthracnose of cotton is the one disease

which is apparently doing greater injury than any other in the State at present, and I trust that arrangements will soon be completed by which I can take up the study of this disease as a problem, under the Adams fund.

There are a number of other problems which stand in urgent need of investigation. Among these are: the question regarding purity of commercial standard of seed purchased in this State, and injurious weeds, etc., introduced with them; a study of sanitary conditions in the State, and a detailed study of the organisms and conditions which cause the rotting of sweet potatoes.

Respectfully submitted.

HENRY W. BARRE,
Botanist and Bacteriologist.

REPORT OF PROFESSOR OF ANIMAL INDUSTRY AND DAIRYING.

Clemson College, S. C., November 22, 1907.

Prof. J. N. Harper, Director South Carolina Experiment Station.

Sir: I herewith submit the following report of work accomplished in this division during the year ended July 1, 1907.

In response to an ever-increasing demand for information concerning the compounding of cattle foods, a bulletin—No. 128—was published on this subject, including with it a few pages devoted to the discussion of silos and ensilage, methods of growing, handling and feeding the crop, construction of the silo, with cut of the same.

The results obtained from feeding cotton-seed meal, as a sole ration of grain, and with corn ensilage as the entire roughage, was published in Bulletin No. 131. This work was carried on for eight months, and with a maximum six pounds of cotton-seed meal, no ill results were obtained. The cattle appeared to relish the food, did not crave other roughage, kept in good thrift and flesh, gave rather more milk than during the same season of previous year, and were not injured in any way by use of this grain. The butter made from the milk obtained was of high quality.

An attempt has also been made to establish a "gathered cream plant," as outlined in Bulletin No. 118, and much interest was taken in the enterprise, the product of more than 500 cows having been promised; but, up to the present time, it has been impossible to finance the scheme. It is hoped we may yet establish the plant, as one in successful operation would create much added interest in the dairy problems of the State.

Respectfully submitted. D. O. NOURSE,

Professor of Animal Industry and Dairying.

REPORT OF SECRETARY AND LIBRARIAN.

Clemson College, S. C., November 14, 1907.

Prof. J. N. Harper, Director South Carolina Experiment Station.

Dear Sir: In response to your request, I beg to submit the following report of some of the work performed in the office of the Secretary and Librarian of the South Carolina Experiment Station, covering the period of the fiscal year beginning July 1, 1906, and ending June 30, 1907.

The work of this office continues to grow in volume and importance. The accounts of receipts and expenditures are carefully kept. A separate account is kept with each division of the Experiment Station. A complete separation in keeping the accounts of the expenditures of the Hatch and Adams funds is required by law and is specially observed.

During the year just closed twenty-two (22) Press Bulletins, containing the analyses of commercial fertilizers, of four pages each, were published at the College, and distributed weekly from this office in editions of 13,000 copies each, to practically as many farmers in the State before the purchases of fertilizers were made. Probably in no one particular has the work of this Station been of more direct benefit to farmers, especially in a State like South Carolina, than the inspection and investigation of fertilizers, and the prompt diffusion among them of such information as may be elicited. The beneficial effects of this work are held in greater appreciation each succeeding year. The agricultural public can not afford to lose interest in the maintenance of the purity of a product the annual sales of which exceed, in this State alone, $11,000,000 and directly affects 30,000 of our farmers. Then many of the more successful farmers, through the information conveyed in our bulletins, circulars and a large correspondence, have been enabled to make their purchases more intelligently and economically, and they know what they are using in the terms nitrogen, phosphoric acid and potash.

There were also eight other bulletins published and distributed from this office. These represent quite a variety of interesting agricultural subjcts, such as "Forage Crops," "Water Content," "Melting Point and Keeping Quality of Butter," "Alfalfa or Lucerne," "Stock Feeding," "Improvement of the Wood Lot," "Methods of Eradicating Cattle Ticks," "Cotton Seed Meal and

Corn Silage as a Ration for Dairy Cows," and "The Williamson Plan of Corn Culture." These all contain much useful information and embody in the main the fundamentals of agricultural production, such as greater varieties, larger yields and higher qualities in every product. The collection and dissemination of such information have stimulated a rapid growth of purpose and sentiment in our rural schools to have the benefits of agricultural investigation placed within their reach. Many of the public schools of the State are on the Station's mailing list by special request.

The aggregate number of bulletins distributed from this office during the past year amounted to 390,000 copies. They were never more popular nor in greater demand than now. The manifest appreciation in which they are held may be seen in the large number of accessions that have been added to the Station's permanent mailing list the past year. These number 2,438. Constant vigilance is exercised with special reference to better methods for the promotion of a still wider diffusion of agricultural literature among our rural population.

With our rapidly growing mailing list, which now contains the names of 13,400 of our leading citizens, it has now become necessary to print an edition of 14,000 copies of each bulletin, in order to supply all the multitudinous demands that are usually made upon this office.

A complete file of all the bulletins issued by the various experiment stations in the United States and many foreign countries is received and preserved. These are specially cared for. Their titles and numbers are systematically recorded in the Bulletin Catalogue, and they are made easy of access for ready reference. When a reasonable number of volumes are acquired they are arranged into appropriate form and bound for permanent use. There are about five hundred such volumes in the library at present. It may be said that this work constitutes a repository out of which the materials may be obtained to construct in the near future a definite science of agriculture, and on which various courses of agricultural instruction may be successfully formulated and founded.

Respectfully submitted.

JNO. N. HOOK,
Secretary and Librarian.

REPORT OF VETERINARIAN.

Clemson College, S. C., November 30, 1907.

Prof. J. N. Harper, Director South Carolina Experiment Station, Clemson College, S. C.

Dear Sir: I have the honor to submit the following report of the work of the Division of Veterinary Science for the year ended June 30, 1907:

The study of the disease caused by the stomach worm (Strongylus contortus) in young cattle and sheep has been continued in co-operation with the Division of Entomology and Zoology. Some progress has been made in obtaining valuable information concerning the life history of the worm, the treatment of the disease and the eradication of the parasite from infested pastures, but there is yet much to be learned along these lines, and the work will have to be continued for another year, at least.

The series of experiments planned to test several methods of eradicating cattle ticks has been completed, and a practical, economical method adapted to the conditions existing on the plantations in this State has been developed. A full report of the work has been published in Bulletin No. 130. These experiments were conducted in co-operation with the Pathological Division of the United States Department of Agriculture.

Respectfully submitted.

LOUIS A. KLEIN,
Veterinarian.

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Twenty-first Annual Report

OF THE

SOUTH CAROLINA EXPERIMENT STATION

OF THE

Clemson Agricultural College

FOR THE YEAR ENDING
JUNE 30, 1908

COLUMBIA, S. C.
THE R. L. BRYAN CO., PRINTERS
1908

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J. M. Burgess, B. S., *Herdsman.*

W. D. Garrison, B. S., *Foreman of Station Farm.*

Miss Helen Bradford, *Stenographer.*

Mail and telegraph: Clemson, S. C.

Freight and express: Calhoun, S. C.

The Bulletins of the Station are issued at irregular intervals, and are sent free to all citizens of the State who apply for them.

LETTER OF TRANSMITTAL.

Clemson College, S. C., November 20, 1908.

Hon. M. F. Ansel, Governor of South Carolina.

Sir: I have the honor to submit herewith the Twenty-first Annual Report of the South Carolina Agricultural Experiment Station, in accordance with the requirements of an Act of Congress, approved March 2, 1887, for the establishment of Agricultural Experiment Stations in connection with the colleges of the several States, organized under the provisions of an Act approved July 2, 1862.

Respectfully submitted,

P. H. MELL, President.

REPORT OF DIRECTOR.

Clemson College, S. C., November 26, 1908.

Dr. P. H. Mell, President, Clemson College.

Dear Sir: I have the honor to submit herewith the Twenty-first Annual Report of the South Carolina Experiment Station for the fiscal year ending June 30, 1908:

The work of the Station continues to grow in importance and efficiency, and now that the Station has been separated from the other departments of the College and made into a separate department by a recent act of the Board of Trustees, its usefulness will be greatly extended. It is now the generally accepted opinion of agricultural workers that only a few men can be good investigators and at the same time first class teachers. To work out the many problems confronting the farmer it is necessary to have a corps of workers who will devote their entire energies to these problems and not have their time taken up by routine duties that are imposed upon a teacher. During this fiscal year the officers of the Station were compelled to devote a considerable portion of their time to instructional work in the College, owing to the large number of students taking the agricultural course.

That the work of the Station is being appreciated and more fully understoood by the farmers of the State is evidenced by the great number of letters that come to the Station officers from farmers in the State and from other States.

The functions of the Station and the character of the work that it is doing meet fully the demands of the farmers. During the year the Station officers wrote about eight thousand letters to farmers, giving information on a great variety of subjects, and every day's mail brings a great number of requests for the bulletins which have been issued by the Station. A great many of these requests for bulletins cannot be granted because the first editions are exhausted, and a second edition of some of the most popular bulletins has been issued, and even then the demand has been greater than the supply. The farmers of South Carolina are waking up to the opportunities now afforded them by their Agricultural College, their Experiment Station and the work that is being done by the U. S. Department of Agriculture.

This Station continues its experiments to determine the most economical fertilizers to be used on the different soil types found in the State for the various staple crops. Valuable information has been obtained from these experiments. This State is now spending something over $12,000,000 per year for commercial fertilizers, and it is putting it conservatively to say that at least $2,000,000 is lost to the farmers of the State by their not knowing the proper proportion of the different ingredients that make up the fertilizers for their different soil types, and by not applying this fertilizer in proper amounts and proportions necessasry to the various crops. Our experiments further show that the farmers lose considerable money by applying large amounts of commercial fertilizers, year after year, to cotton without growing their crops in proper rotation. Where crops have been grown in rotation, including legumes, such as cowpeas, bur clover and vetch, more profit is obtained from the commercial fertilizers used.

This Station has continued to grow a great number of varieties of cotton for the purpose of determining the best type of cotton suited to the different soil types of the State and to obtain a variety or strain that is more or less resistant to disease, and also to obtain a variety with a larger boll and a higher yield of lint. Some attention has been paid also to the selection and development of varieties producing a lint of fine quality and length.

The Station is also breeding corn with the view of increasing the yield of grain and also to obtain a smaller, stronger stalk and uniformity in ripening.

Experiments to determine the best time of applying nitrate of soda as a top dressing to cotton have been continued. Our results show that where nitrate of soda is applied at the rate of about 100 lbs. per acre to cotton at the time the plant begins to make its fruit, the yield is increased to a considerable extent. The applications made about July 1st gave the largest yield. The results obtained varied with the amount of humus in the soil, the type of soil, and the moisture conditions at the time of applying.

Experiments to determine the relative value of nitrate of soda and cotton seed meal as the source of nitrogen have led to some interesting results. On poor soils depleted of humus, the first year nitrate of soda, where put on in two applications, gave better results than where cotton seed meal was used; the same amount of nitrogen being used in both cases. The second year, however, the plots receiving the cotton seed meal out-yielded the plots receiving nitrate of soda.

It is the object of the Station to encourage diversified farming, for it is our belief that the one crop system is at the root of most of the evils confronting the Southern farmer. As long as the farmers of the South continue to plant cotton without rotating, we can never hope to build up a great agricultural country. Our cotton seed meal, which is a most valuable food, is being used in large quantities as a commercial fertilizer. This is not economical. There is enough cotton seed meal each year strewn over our land as a fertilizer to feed thousands and thousands of cattle.

Alfalfa is now receiving considerable attention by the Station. We have a field that is producing more than three tons of hay per acre. These experiments lead us to believe that alfalfa can be grown in a number of sections of the State successfully when the proper conditions are maintained. It is highly necessary to apply lime, at the rate of about 1,000 lbs. per acre, and to apply an abundance of acid phosphate at the time of planting, and a good, liberal supply of stable manure. It is our belief that where failures have been made in the State with alfalfa it has been due to the lack of these necessary factors.

Experiments to determine the best time to apply fertilizers to oats have led us to the conclusion that this cereal should have an ample supply of nitrate of soda and a small amount of acid phosphate and potash applied to it in the spring,—this in addition to the fertilizer applied when the oats were planted in the autumn.

Other experiments being conducted by the Station in the Agricultural Division, are variety tests of wheat, corn, alfalfa, vetch, cowpeas and sweet potatoes.

The work done by the Chemical Department of the Station in the manufacture of starch from the sweet potato, has been of especial interest. That department has issued a most valuable bulletin on this subject. The soils of South Carolina are well adapted to the growing of sweet potatoes. Several hundred bushels are often produced on one acre of land, and from the results that have been obtained by the Chemical Department, we are of the opinion that the manufacture of starch from the sweet potato could be made a most profitable business in this State. This department of the Station, during the year, made a number of analyses for different divisions of the Station. The detailed report of Col. M. B. Hardin, chief chemist, is found appended.

The Horticultural Division has carried on extensive experiments in the testing and breeding of Rotundifolia grapes. This Station

has done more work with this type of grape than probably any other Station on the continent. The bulletin prepared by the Horticulturist on his experiments with the Rotundifolia grapes has been in great demand by fruit-growers throughout the entire country.

This division of the Station has also conducted experiments in the testing of Irish potatoes, comparing the first and second crop for spring planting, and comparing Northern and Southern grown seed for seed purposes, also experiments to determine the effect of spraying with Bordeaux mixture on the yield of Irish potatoes. A number of experiments have been conducted with tomatoes to determine the best variety,—the growing of tomatoes under glass, the breeding of new varieties and the stalk system compared with the ordinary method.

Other experiments made by this division are methods of blanching and storing celery, testing varieties of celery, comparing the keeping quality of onions grown from seed and grown from sets, variety test of onions covering a period of a number of years, experiments in the breeding of new varieties of onions, experiments with 125 varieties of grapes, the testing of a number of varieties of apples, peaches, pecans, strawberries and muskmelons.

The Division of Veterinary Science has continued the work begun last year to determine the most practical methods of freeing pastures from the stomach worm. Results of these experiments will be published soon in bulletin form. This division, during the past year, issued a very instructive bulletin on the oxygen treatment for milk fever.

The Division of Entomology and Zoology has undertaken very extensive investigations to determine the biological character of the stomach worm. Some interesting results have been obtained from these experiments. This division is also investigating the ravages of the hook worm. A biological study is being made of the worm, and experiments conducted to determine the most practical method of eradicating it from pastures.

Other experiments being conducted by this division are: A study of the life history of the peach tree borer and its control; a study of the life history of the codling moth and its control; a study of the life history of the plum curculio and its control; a study of the life history of pecan insects and their control.

The work of the Division of Animal Husbandry of the Station, in determining the safest amount of cotton seed meal to feed to dairy cattle, when fed in conjuction with corn silage, is probably one of the

most interesting problems taken up by the Station. A portion of the Station herd has been fed cotton seed meal at the rate of six pounds per day per animal, without causing any apparent ill effects, after having been fed this amount for three years. This division has arrived at the conclusion that corn silage and cotton seed meal constitute the most economical ration to feed to dairy cattle at present for this section of the country. Corn silage can be produced more economically in South Carolina than in many of the Northern States that have made the dairy industry a success, while we have at our very doors a most valuable concentrated food in the form of cotton seed meal, which the Northern dairyman buys and transports.

It is the hope of this Station that the dairy industry will soon receive from the farmers the attention it richly deserves, as it is our belief that this is the most profitable line of business in which a number of farmers can engage. The South has yet an unlimited dairy market.

This division has also conducted experiments to determine the most economical grain ration for hogs.

The work of the Botanist and Bacteriologist of the Station was confined mainly to the study of the life history of the fungus, which causes anthracnose of cotton, and experiments relative to controlling the same. This has become one of the most destructive diseases to be found in the State. It is now causing the loss of thousands of dollars, and any remedy that will control and prevent the spread of this disease will be worth millions of dollars to the farmers of the South. This division conducted investigations of other diseases of cotton, such as root rot, boll rot, wilt, leaf spot, etc.; and experiments were conducted with the view of preventing the rotting of sweet potatoes. Valuable information concerning the fungi which cause the rotting has been obtained, and we are in hopes that in the near future methods of keeping the sweet potato will be devised that will be simple and economic.

Other experiments undertaken by this division were investigations in reference to the distribution and prevalence of the plant diseases present in the State, such as rust of wheat, oats, corn; smut of wheat, barley; powdery mildew of grain; leaf spot of vetch, clovers, etc.

During the past year the Station issued nine bulletins and one annual report. These were issued in editions of about 14,000 each. The Station now has on its mailing list more than 14,000 persons engaged in or interested in agriculture. In addition to these regular

bulletins there were distributed by the Secretary twenty-two weekly bulletins in editions of 14,000.

Detailed reports of the divisions of the Station are found appended.

This Station continues to cooperate with the U. S. Department of Agriculture in the following experiments: The testing of citrange trees with the Bureau of Plant Industry in cooperation with our Horticultural Division; the Entomological Division is cooperating with the Bureau of Entomology with cereal and forage crop insects; the Division of Botany is cooperating with the Bureau of Plant Industry in making a plant disease survey of the State, and with the Bureau of Forestry in testing methods of preserving fence posts with creosote; and the Agricultural Division is cooperating with the Bureau of Chemistry in the breeding of sweet corn; and cooperating with the Bureau of Plant Industry in testing various forage plants.

Most respectfully submitted,

J. N. HARPER,
Director.

SOUTH CAROLINA AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH THE UNITED STATES APPROPRIATION, 1907-1908.

Debtor.		Hatch Fund.	Adams Fund.
To receipts from the Treasurer of the United States as per appropriations for fiscal year ended June 30, 1908, under Acts of Congress, approved March 2, 1887 (Hatch Fund), and March 16, 1906 (Adams Fund).		$15,000 00	
Credit.	**Abstract.**		
By Salaries	1	8,078 65	$4,441 42
Labor	2	1,391 06	1,285 99
Publications	3	2,262 72	
Postage and stationery	4	87 61	52 02
Freight and express	5	173 21	14 40
Heat, light, water and power	6	16 37	
Chemical supplies	7	79 72	119 77
Seeds, plants and sundry supplies	8	444 58	72 65
Fertilizers	9	438 93	226 18
Feeding stuffs	10	784 00	1,731 65
Library	11	89 23	

Tools, implements and machinery	12	199 04	189 25
Furniture and fixtures	13	16 15	5 50
Scientific apparatus	14	.....	464 95
Live stock	15	408 00	34 00
Traveling expenses	16	50 06	9 70
Contingent expenses	17	15 00	
Buildings and land	18	338 17	311 87
Fences and drainage	19	127 50	40 65
Total		$15,000 00	$9,000 00

We, the undersigned, duly appointed Auditors of the Corporation, do hereby certify that we have examined the books and accounts of the South Carolina Agricultural Experiment Station for the fiscal year ended June 30, 1908; that we have found the same well kept and classified as above; that the receipts for the year from the Treasurer of the United States are shown to have been $15,000 under the Act of Congress of March 2, 1887, and $9,000 under the Act of Congress of March 16, 1906, and the corresponding disbursements $15,000 and $9,000; for all of which proper vourchers are on file and have been by us examined and found correct, thus leaving balances of $ and $.

And we further certify that the expenditures have been solely for the purposes set forth in the Acts of Congress, approved March 2, 1887, and March 16, 1906, and in accordance with the terms of said Acts, respectively.

(Signed) R. W. SIMPSON,
Chairman Finance Committee, Auditors.

Attest: P. H. E. SLOAN, Custodian.

SOUTH CAROLINA AGRICULTURAL EXPERIMENT STATION, 1907-1908.

(Supplementary Statement.)

(This supplementary statement, while not required by law, is desired as an aid in interpreting the account rendered for the United States appropriation. While it will be more useful if made in conformity with the schedule fixed for that appropriation, if this is not practicable such a summary of receipts and expenditures from the sources indicated below as can be conveniently prepared from the books of the Station may be substituted. Whenever practicable, it should be for the fiscal year ended June 30.)

DEBTOR.

To Receipts from Other Sources Than the United States of the Year Ended.

Balance July 1, 1907	$1,628 01	
Received to July, 1908	1,809 75	
Total		$3,437 76

CREDIT.

By Salaries	$754 12	
Labor	71 40	
Publications	113 62	
Postage and stationery	5 19	
Freight and express	30 19	
Seeds, plants and sundry supplies	251 79	
Fertilizers	4 65	
Library	17 86	
Live stock	5 00	
Traveling expenses	8 82	
Contingent expenses	74 05	$1,336 69
Balance		$2,101 07

REPORT OF CHEMIST.

Clemson College, S. C., September 19, 1908.

Prof. J. N. Harper, Director, South Carolina Experiment Station.

Sir: I respectfully submit the following report of the Chemical Department of the Station for the year ending June 30, 1908:

The work done by Mr. C. C. McDonnell in 1905 and 1906 on the manufacture of starch from sweet potatoes has been published in Bulletin 136. As Mr. McDonnell resigned his position here in March, 1907, the dried samples of potatoes, pulp, and starch of 1906 were placed in the hands of Mr. T. E. Keitt, whose analyses appear in the Bulletin referred to. The work was continued in 1907, but on account of unavoidable difficulties the investigation was not carried out fully in accordance with the original plan. However, Mr. B. F. Robertson prepared nearly one hundred pounds of starch from the variety of potatoes known as Southern Queen, and over sixty pounds from a mixture of six varieties, the samples of which were too small for separate runs. The analyses of the potatoes, pulp and starch were made by Mr. T. E. Keitt. The results of the work in 1907 were about the same as those obtained in 1905 and 1906.

Mr. D. H. Henry made for the Dairy Division a determination of the melting point of a fat, and did some very interesting work in cooperation with the Agricultural Department on five samples of soil, two surface and three sub-soils, sent by a citizen of the State on account of marked differences in plant growth on different parts of the same small area.

The Department sustained a loss last December in the death of Mr. F. S. Shiver, who had been a faithful and efficient Station officer since 1891, and, in addition, an Instructor and Assistant Professor of Agricultural Analysis since 1895.

ANALYSIS OF COMMERCIAL FERTILIZERS.

Following is a report of the work on commercial fertilizers done under the direction of the Board of Fertilizer Control:

SUMMARY.

	1906-7.	1907-8.
Official samples	743	713
Farmers' samples	43	45
	786	758

Fifteen official samples were analyzed, which are not included in the foregoing summary, as the analyses were not published in Bulletin No. 138, which is the basis of the present report.

OFFICIAL SAMPLES OF FERTILIZERS.

The analyses of 713 samples are given in full in Bulletin No. 138.

Classification.

	1907.	1908.
Complete fertilizers	390	363
Acid phosphates	111	91
Acid phosphates with potash	72	64
Cotton seed meals	99	114
Kainit	30	39
Nitrate of soda	20	17
Muriate of potash	13	15
Nitrate of potash	0	1
Sulphate of potash	1	2
Nitrate of soda with potash	3	0
Dried blood	1	4
Miscellaneous	3	3
Total	743	713

Deficient Samples.

Of the 713 samples reported, 55 fell below the commercial value, based upon guarantee, and of these, 25 fell 3 per cent. or more below that value.

In addition to these there were 161 samples below the guarantee in one or more constituents, the deficiency, however, being made up by an excess of other constituents.

They are as follows:

In available phosphoric acid	18
In available phosphoric acid and potash	1
In ammonia and potash	11
In ammonia	77
In potash	54
Total	161

The extent to which they fell below guarantee is shown in the following table:

	Below Guarantee—Per Cent.				
	0-.10	.10-.25	.25-.50	.50-1.00	1.00 and over
In available phosphoric acid	3	5	5	3	3
In ammonia	22	42	20	4	0
In potash	9	19	22	14	2
Total	34	66	47	21	5

AVERAGES OF ANALYSES.

	1907 Per Cent.		1908 Per Cent.	
	Found	Guaranteed	Found	Guaranteed
ACID PHOSPHATES—				
Soluble phosphoric acid	11.17	.....	11.29	.....
Reverted phosphoric acid	3.78	.....	3.42	.....
Available phosphoric acid	14.95	14.10	14.71	14.18
Insoluble phosphoric acid	.66	.....	.65	.....
Total	15.61	.....	15.36	.....
ACID PHOSPHATES WITH POTASH—				
Soluble phosphoric acid	7.62	.....	7.12	.....
Reverted phosphoric acid	3.14	.....	3.45	.....
Available phosphoric acid	10.76	9.91	10.57	9.91
Insoluble phosphoric acid	.72	.....	.66	.....
Total	11.48	.....	11.23	.....
Potash soluble in water	3.21	3.11	3.54	3.34
COMPLETE FERTILIZERS—				
Soluble phosphoric acid	6.27	.....	6.32	.....
Reverted phosphoric acid	2.64	.....	2.85	.....
Available phosphoric acid	8.91	7.92	9.17	8.28
Insoluble phosphoric acid	1.45	.....	1.36	.....
Total	10.36	.....	10.53	.....
Ammonia phosphoric acid	3.29	3.24	3.01	2.91
Potash soluble in water	3.29	2.71	3.01	2.77
COTTON-SEED MEALS—				
Available phosphoric acid	2.68	1.48	2.37	1.50
Ammonia	7.32	6.91	7.40	7.03
Potash soluble in water	1.69	1.00	1.61	1.00
KAINIT—				
Potash soluble in water	12.78	12.00	12.91	12.00
MURIATE OF POTASH—				
Potash soluble in water	51.52	48.75	51.04	48.84
SULPHATE OF POTASH—				
Potash soluble in water	48.20	48.00	50.09	48.00
NITRATE OF SODA—				
Ammonia (equivalent)	18.49	18.26	18.33	18.07

The following table shows the yearly averages of fertilizer anaylses from the time the Board of Trustees of this College took charge of the Station work down to the present time:

YEARLY AVERAGES OF ANALYSES FROM 1891 TO 1908, INCLUSIVE.

SEASON	Acid Phosphates		Acid Phosphates with Potash			Complete Fertilizers				Cotton Seed Meals				Kainits		Muriate of Potash		Nitrate of Soda.	
	Number of Samples	Available Phosphoric Acid Per Cent.	Number of Samples	Available Phosphoric Acid Per Cent.	Potash, Soluble in Water Per Cent.	Number of Samples	Available Phosphoric Acid Per Cent.	Ammonia Per Cent.	Potash, Soluble in Water Per Cent.	Number of Samples	Available Phosphoric Acid Per Cent.	Ammonia Per Cent.	Potash, Soluble in Water Per Cent.	Number of Samples	Potash Per Cent.	Number of Samples	Potash Per Cent.	Number of Samples	Ammonia Per Cent.
1890-1..	49	13.02	19	11.84	1.65	173	9.34	2.68	1.96	30	.....	8.37	.....	21	12.75	1	51.96	1	19.22
1891-2..	29	12.92	16	11.50	1.49	112	8.83	2.80	1.95	25	.....	8.21	.....	18	12.51	....	.....	1	18.63
1892-3..	48	12.32	26	11.63	1.22	150	9.00	2.91	1.65	20	2.62	8.40	1.32	20	12.05	....	.....	....	.....
1893-4..	46	13.24	22	12.01	1.51	132	9.27	2.53	1.79	22	2.45	8.64	1.69	17	12.37	....	.....	....	.....
1894-5..	46	13.55	15	12.09	1.66	87	9.42	2.55	1.77	33	2.58	8.19	1.66	19	12.30	....	.....	....	.....
1895-6..	42	13.43	26	11.99	1.39	115	9.31	2.64	1.86	34	2.57	8.45	1.61	16	12.45	....	.....	....	.....
1896-7..	59	13.61	34	12.06	1.61	117	9.55	2.70	1.91	40	2.53	8.69	1.64	22	12.44	....	.....	....	.....
1897-8..	63	13.67	50	11.54	2.06	141	9.15	2.70	1.93	39	2.37	8.39	1.58	20	12.68	....	.....	1	19.23
1898-9..	73	13.74	68	11.77	1.99	134	9.32	2.73	2.21	40	2.76	8.25	1.75	14	12.78	2	51.93	2	18.96
1899-1900..	73	13.58	63	11.58	2.00	124	9.50	2.73	2.13	52	2.27	8.73	1.63	8	12.73	4	50.95	3	19.01
1900-1..	56	14.00	55	11.49	2.65	139	9.40	2.87	2.47	60	2.38	8.55	1.54	12	12.61	2	48.92	3	18.96
1901-2..	45	14.11	51	11.09	2.55	141	9.39	2.84	2.34	49	2.57	7.93	1.63	16	12.85	4	50.54	3	19.03
1902-3..	51	13.74	55	10.94	2.65	139	9.02	2.69	2.42	69	2.27	8.08	1.48	15	12.92	2	50.25	2	19.15
1903-4..	59	14.32	75	11.12	2.81	180	9.12	2.99	2.90	57	2.28	7.92	1.54	11	12.94	7	49.79	6	18.87
1904-5..	81	14.81	82	10.70	3.07	250	9.19	3.12	2.90	62	2.41	7.42	1.54	26	12.54	6	50.49	7	18.73
1905-6..	87	14.95	94	10.97	3.30	375	9.34	3.26	2.98	71	2.42	7.51	1.57	29	12.83	13	50.05	19	18.67
1906-7..	111	14.95	72	10.76	3.21	390	8.91	3.29	3.29	99	2.68	7.32	1.69	30	12.78	13	51.52	20	18.49
1907-8..	91	14.71	64	10.57	3.54	363	9.17	3.01	3.01	114	2.37	7.40	1.61	39	12.91	15	51.04	17	18.33

In this table, as in the preceding ones, the ammonia yielded by the nitrogen in fertilizers is given instead of the nitrogen itself, as in the trade goods are still bought and sold on the ammonia basis. The per cent. of nitrogen is readily calculated, as fourteen-seventeenths of the ammonia is practically the weight of the nitrogen it contains.

Grades.

In the following table the number of acid phosphates, acid phosphates with potash, and complete fertilizers of each grade, according to the guarantee, is placed side by side with the number found by analysis to belong to that grade, fertilizers having commercial values equal to those of schedule grades being classed in those grades:

	High		Standard		Low	
	Claimed	Found	Claimed	Found	Claimed	Found
Complete fertilizers (363)	186	222	156	132	21	9
Acid phosphates with potash (64).	34	49	30	11	0	4
Acid phosphates (91)	90	91	1	0	0	0
Total (518)	310	362	187	143	21	13

These results are due to the following changes in grades, ascertained by analysis:

	Low to High	Low to Standard	Standard to High	High to Standard	High to Low	Standard to Low	No change
Complete fertilizers (363)	2	13	39	5	0	3	301
Acid phosphates with potash (64)	0	0	17	2	0	4	41
Acid phosphates (91)	0	0	1	0	0	0	90
Total (518)	2	13	57	7	0	7	432

This shows that out of 518 samples, 432 were of the grade claimed for them, 72 were of a higher grade, and 14 of a lower grade than that claimed for them. Last year out of 573 samples, 479 were of the grade claimed for them, 85 were of a higher grade, and 9 of a lower grade than that claimed for them.

Farmers' Samples of Fertilizers.

In addition to the samples of fertilizers collected by the official inspectors there have been analyzed this year 45 samples for individual purchasers as provided for in Section 1540 of the law respecting commercial fertilizers.

Water.

There have been made this year 50 analyses of water from different parts of the State. Of these 42 were sanitary examinations, the rest mineral water analyses.

Distribution of the Work.

Fertilizers were analyzed by Messrs. B. F. Robertson, J. H. Mitchell, T. E. Keitt and C. V. Cornell; water mainly by Mr. D. H. Henry. Dr. R. N. Brackett aided me in office duties, and made addresses at twelve Farmers' Institutes.

Very respectfully,

M. B. HARDIN,
Chief Chemist.

REPORT OF HORTICULTURIST.

Clemson College, S. C., November 25, 1908.

Prof. J. N. Harper, Director, S. C. Experiment Station.

Dear Sir: I beg to submit the report of the progress of the experiments conducted in the Horticultural Division of the South Carolina Experiment Station for the year ending June 30, 1908.

The experiments conducted during the past year have been practically the same as those mentioned in my last report, with the exception that a few mentioned in the report of 1907 have been completed and therefore discontinued.

Our experiments in breeding tomatoes, muskmelons and grapes have been continued.

We have now under way about four hundred seedling tomatoes, most of which are crosses made from the leading varieties with special reference to securing a variety resistant to plant diseases. In our lot of seedlings tested last year three of the number produced tomatoes of fine shape and size and the fruit was decidedly freer from diseases than any of the varieties tested. We have made quite a number of crosses from these seedlings during the past year and hope to produce some valuable varieties.

The breeding experiments with the muskmelons were continued under glass during the winter and then in the field in the spring. By growing these melons under glass in the winter and continuing the crossing enables us to get results more rapidly than we would be able to do otherwise. We have several varieties now under way that appear to be practically free from the wilt disease. These varieties, however, will be tested more thoroughly during the coming season.

Our crosses made from vareties of Rotundifolia grapes are doing well, but as yet none of them have produced fruit.

Our experiments in growing cabbages for fall and winter have been continued. Our best results have been obtained from plants set in the field August 15th. These cabbages were ready for cutting by October 20th, many of the heads at that time weighing from four to six pounds. By November 25th the majority of cabbage had reached maturity, the heads weighing from six to fourteen pounds. Cabbage plants set in the field the fifteenth of September produced heads averaging about two pounds less than those planted the 15th of August. Plants set out the 15th of October headed up nicely during

the months of January and February. The heads, however, were rather small, averaging three and a half pounds. The best variety to use for winter is the Drum Head Savoy. This variety will stand more cold than any we have tested. If the plants are expected to head before the last of December any of the ordinary winter varieties will do, but if they are to be allowed to remain in the field after this time the Savoy is about the only variety that will not be injured by the severe cold. For fall use the Succession and Charleston Wakefield have given best results, the Charleston Wakefield heading about three weeks earlier than the Succession. The Flat Dutch is probably the best variety to follow the Succession.

For spring planting the cabbage seed should be sown in the open ground some time between October 15th and November 1st. If the seed are sown in the early part of September the plants will make too much growth in the fall and when transplanted the next spring a large percentage of them will run to seed rather than form heads. If the seed are planted about the middle of October the plants will form about five or six leaves before very cold weather and will then remain practically in a dormant condition until spring, when they may be taken up and transplanted to the field where they are to head. It is generally supposed that the cabbage will not withstand our winter, but when planted at the time stated above there is no danger of their being killed provided the temperature does not drop below ten degrees. If the seed are sown in December and the plants do not have time to become well-established before severe weather they will be killed.

Our experiments in pruning okra have been continued, and the results of these experiments have been very interesting. As okra is ordinarily planted the rows are five feet apart and the plants left three feet apart in the row. If the plants are pruned as soon as the side limbs appear, the rows need not be more than three feet apart and the plants may be allowed to stand twelve inches apart in the row. The pruning is very simply done, and there is no necessity of going over the field but once, as the okra does not sprout from the stalk after these limbs have been removed. The yield from the pruned plot is just three times as heavy as that from the unpruned stalks or the ordinary method of growing okra. The lateral branches on the okra plant produce very few pods, but take up a considerable amount of room and prevent the plants from being left close together. The main stem of the okra plant will usually produce from three to four times as many pods as all of the lateral branches combined.

The results of these experiments will be given more fully in the bulletin which is now practically ready for the press.

Our experiments in different methods of keeping the first crop of Irish potatoes have been continued. The past season we kept the first crop of potatoes in perfect condition, not losing one per cent. of the entire lot. Our best results were obtained where the potatoes were put on shelves placed one above the other eighteen inches apart, the first shelf being about twelve inches from the floor of the cellar and the last shelf about six or seven feet from the floor. The shelves are four feet wide and the potatoes may be easily reached from either side or from the alleys extending between the rows of shelves. The bottom of the shelves are covered with three-inch slats placed one inch apart. This affords free circulation of air and keeps the potatoes cool and dry. The potatoes were piled on these shelves about six inches deep.

Our next best results were obtained where the potatoes were placed in slat boxes holding one bushel each and then placed on the slat shelves. This is decidedly the best way of handling the potato, but there is more danger of their rotting when placed in bushel crates. When they are loose on the shelves any decayed potato may be noticed at once and is easily removed, while it is hard to locate and remove the decayed potatoes from the bushel crates. These experiments will be continued during the next year, when our results will be ready for publication.

Our young orchard of seedling apples bore a few fruits this year and some of them are very promising indeed. Next season these trees should produce enough apples for us to tell something about their value. A more detailed account of these experiments was given in our report of 1907. At present the Rabun, Black Winesap and Thin Skin appear to be among the most promising seedlings. Our old apple orchard this year produced a wonderful crop of fruit, many of the trees producing as many as fifteen bushels of perfect apples. The trees were so heavily loaded, however, that the fruit was below the average in size.

The pecan trees all produced a fair crop this season and some of the seedling trees produced nuts of excellent quality, and we believe they are worthy of propagation, especially for planting in the Piedmont section of this State. A great many of the best varieties of pecans fail to mature their nuts before frost in this section of the State, and therefore it is of great importance that we secure, if possible, a first-class early variety that will mature its nuts before frost.

We were able this year to secure detailed descriptions of more than one hundred varieties of grapes. These notes, combined with notes taken during the past four years, are now being put in shape for publication.

Our experiments in growing tomatoes under glass have been continued.

Our experiments in grafting apples in order to determine the length of stock and scion to use to produce the largest number of first grade trees, have been continued. The results in the accompanying table will be of interest to those who grow apple trees for the trade.

Straight or Western stocks were used in this experiment.

There were ten grafts in each plot:

PLOT	Length of Stock used	Length of Scion used	Average height of Trees after first year's growth	Number of first grade Trees produced	Number of second grade Trees produced	Number of third grade Trees produced	Number of Grafts that failed to grow
1	12 in.	18 in.	5 ft.	6	3	1	0
2	12 in.	12 in.	5 ft. 6 in.	8	2	0	0
3	12 in.	8 in.	5 ft. 8 in.	8	2	0	0
4	12 in.	4 in.	5 ft. 8 in.	10	0	0	0
5	12 in.	2 in.	5 ft. 8 in.	9	1	0	0
6	6 in.	18 in.	3 ft. 8 in.	0	6	4	0
7	6 in.	12 in.	4 ft. 6 in.	6	3	1	0
8	6 in.	8 in.	5 ft.	8	2	0	0
9	6 in.	4 in.	6 ft.	10	0	0	0
10	6 in.	2 in.	6 ft.	10	0	0	0
11	3 in.	18 in.	3 ft.	0	1	4	5
12	3 in.	12 in.	3 ft. 6 in.	0	3	5	0
13	3 in.	8 in.	4 ft. 6 in.	0	6	3	1
14	3 in.	4 in.	5 ft. 3 in.	4	5	1	0
15	3 in.	2 in.	5 ft.	8	1	1	0

Respectfully,

C. C. NEWMAN,
Horticulturist S. C. Experiment Station.

REPORT OF AGRICULTURIST.

Clemson College, S. C., June 30, 1908.

Prof. J. N. Harper, Director, S. C. Experiment Station.

Dear Sir: I respectfully submit the following report for the Agricultural Division of the Experiment Station:

In my report of November 23, 1907, it was stated that material was ready for five bulletins. Since this report was submitted two of these bulletins have been prepared and one, "The Williamson Plan in 1907," has been published; the other, "Cotton in 1907," is now in the hands of the printer. Time has not been found for the completion of the other three. These embrace work done with cowpeas, wheat and corn.

The work begun with cotton three years ago has occupied more of my time and attention than probably all other work undertaken. This embraces the study of established varieties and their improvement by pedigree selections; the origination and development of hybrids; and, a study of the qualities of cotton which give value to lint, together with the collection of data showing the great loss, to the farmer producing cotton, resulting from the absence of uniform standards for the grading, classification and pricing of cotton in local and other markets. A preliminary report embracing, in part, data relative to the above problems will be found in Bulletin No. 140. There is no feature of cotton investigation of more importance to the people of the State than that leading to the protection of the producer in the marketing of lint. Cotton overshadows all other crops of the State, and the Experiment Station could well afford to give cotton production the attention it deserves. Several hundred plots of cotton are now growing in the cotton breeding grounds and ample equipment for this work is provided. This work has been undertaken on a larger scale probably than ever before in the United States, and there never was a more appropriate or more opportune time for this character of work. The progress and extent of the work in cotton breeding now under way, if continued, will easily place the Clemson College Experiment Station far in the lead in this paramount line of investigation.

The work with corn, wheat, oats, sorghum, millet, rice, cowpeas, vetch, Soy beans, alfalfa, clover, grass, etc., referred to in previous reports has been continued. A number of strains of alfalfa, flat pea

and vetch have been procured through the National Department of Agriculture and are being grown for the purpose of securing strains adapted to the State. The cooperative corn variety test undertaken at the request of the National Department of Agriculture is concluded; and the sweet corn cooperative work is continued. A number of miscellaneous plants furnished by the Department are being tested, and several minor problems are under investigation or observation.

Respectfully submitted,

C. L. NEWMAN.

REPORT OF GEOLOGIST.

Clemson College, June 30, 1908.

Prof. J. N. Harper, Director, S. C. Experiment Station.

Dear Sir: During the fiscal year ending June 30, 1908, sixty photographs and photo-micrographs were taken for the other officers of the Station engaged in experiment work. Minerals, rocks, clays, sands, soils and road materials sent to the division by people in the State were examined and reported upon. Material for a bulletin upon gullying, its cause and its prevention, was gathered and photographs to illustrate the same were taken. Material collected last year for a bulletin upon the geological relations of soils in South Carolina was turned over to the Division of Agronomy. Meteorological observations were continued during the year.

Respectfully submitted,

(Signed) F. H. H. CALHOUN,
Geologist.

REPORT OF ASSOCIATE PROFESSOR OF ANIMAL INDUSTRY AND DAIRYING.

Clemson College, June 30, 1908.

Prof. J. N. Harper, Director, Agricultural Experiment Station.

Sir: Cotton seed meal has been used as a grain for cattle for many years, and in most sections a feeling prevails that its use in even moderate quantities is liable to produce troubles more or less alarming, particularly when given to dairy cows and hogs.

The writer must confess to having had this feeling very firmly fixed from rumors heard in early life and has seen it proven to be true, so far as its use for swine is concerned, but opinion of results following its use for cattle has been considerably modified. Having seen steers in Virginia fed large quantities of cotton seed meal, and it being used with no other grain, caused us to more and more rely on it as a food for dairy cows, and the increased amount given was not attended by any evil.

On coming to this Station, in September, 1907, we found that cotton seed meal had been used in even larger quantities than we had before fed it, and that it had been the exclusive grain ration for a year or more. We determined to continue its use with a large portion of the herd, to study its effects and note any ills it might bring when fed continuously for a long period. This is a question of great import to the entire South, and to a lesser extent, to all the dairy sections of the North, for in these years of extremely high prices of most grains, this product has not advanced in proportion with the others, and if demand can be increased, it must mean added income to the cotton grower and an economical grain for the Northern dairyman.

In our feeding experiments the aim was primarily to study the effect of the meal on the dairy cows, when fed in some considerable quantity, i. e., five to six pounds per day to average sized Jersey cows, said amount being slowly decreased as period of lactation advanced. Beside this, we desired to show cost of butter production with cotton seed meal as the grain ration, that we might compare its value to other grains, particularly as most other concentrates are purchased in large quantities in Southern States.

In many portions of the country, the great cry is for concentrates and roughages that can with economy supply the necessary protein.

In this State we have no such question if we can use the cotton seed meal, particularly when we can so easily grow cowpeas. With these two crops, we may feed an excess of protein and yet keep the cost of such feeds at a low point. Again, as corn can be grown easily, and as the larger varieties that make fine silage will mature here, this adds an economical food that may be used in conjunction with those before mentioned.

In our work, on account of local conditions and that we might the more easily note effect of the cotton seed meal on our cows, we fed a number of them on corn silage and cotton seed meal, giving *no* other food of *any* kind, except grasses from a rather poor pasture.

Two of the ills most commonly ascribed to the feeding of cotton seed meal are abortion and troubles of the udder, known as garget. The herd we handled was unfortunate enough to have been troubled with contagious abortion several years ago, and was, we understand, so affected when the feeding of the cotton seed meal began, but that it gradually disappeared from the herd, though, of course, such means as segregation, disinfectants, etc., were used as a means to lessen the evil.

During the nine months we conducted the work we had one case of abortion, and while no cause is known for it, the Veterinary Department saw no reason to believe it came from the feeding the cotton seed meal, though no positive assertion can be made in either direction. With this exception the herd has been very healthy. No udder that was in normal condition when we began feeding the meal is now involved with any trouble, and the herd, as a whole, is in a very thrifty condition, and was reported by members of the Board of Trustees at their meeting in July "to appear in better condition than it ever had before."

That silage and cotton seed meal may be used as a feed with economy may be shown by citing the case of a Jersey in the herd, the cow, Exile Bessie, No. 162507:

From February 3, 1907, to February 3, 1908, she produced 7,021.1 pounds milk, and from that gave 442.3 pounds butter, as estimated by the Babcock test. She had pasturage for five months and silage for seven, with six pounds cotton seed meal per day for three months, five pounds per day for seven months and a lesser amount, with bran and linseed meal, near time of dropping calf. The amount of silage varied from 40 to 45 pounds per day, but was as much as she would eat without waste.

When getting her highest feed she obtained 9.4 pounds dry matter from the silage and 5.5 pounds dry matter from the meal, a total of about fifteen pounds, this being much lower than accepted standards call for, yet she not only gave the amount of milk and butter mentioned, but kept in good flesh and gave every evidence of thrift.

This cow and most of the others were given a change of feed just before and after dropping their calves, using some bran and linseed meal, as we desired grains that have laxative properties. We do not contend that cotton seed meal should be given in any considerable quantities at such times, any more than one would give a large ration of corn meal, for the use of either would be attended with some danger, yet in several instances where we continued the use of cotton seed meal through the entire year, we had no bad effects to follow.

Considering the cost of the food given the cow mentioned above, she ate in one year 8,900 pounds silage, 1,720 pounds cotton seed meal, 132 pounds bran and 30 pounds linseed meal, besides grass for five months.

If we consider silage as worth $2 per ton, and figure the grains at cost, the total would not be over $40, including a fair allowance for the pasturage. In fact, had she been fed all grain and silage at rate as averaged for the year, getting *no* grass at all, yet the cost would have been not more than the $40.

This is without doubt the cheapest combination that can be used for this section. It is true many object to the use of only two food stuffs and more would probably be better, though first cost would be greater, but with this as a basis, one may work out rations to suit local conditions.

Oats succeed admirably in most parts of the State, and if sown thick and cut green, they make a hay that would be a valuable addition to the articles consumed. These, with corn stover and pea hay, all of which are easily produced in the South, would answer all needs.

Beside, the animals fed for purposes as above mentioned, we gave to others a ration supplementing half the cotton seed meal with an equal weight of rice bran. The composition of these two grains are such that we might expect them to feed well together, and perhaps they would if the cows became accustomed to the rice while young. With our mature cows, they would at times refuse to eat it, so often indeed, that we could get no basis of comparison.

If given in very small quantities it would, without doubt, prove a good addition to our food stuffs, particularly as at times it is considerably cheaper than most other concentrates.

Summary.

1. Cotton seed meal given at rate of six pounds per day caused no apparent ills after having been fed for three years.
2. Corn silage and cotton seed meal is most economical food at present for this section.
3. With this combination the cows received but little more than half the amount of dry matter that a theoretical correct ration demands, though the protein was nearly up to the standard.
4. That despite this fact the cows gave every evidence of thrift, appeared to digest the food perfectly and gave satisfactory returns in dairy products.

Respectfully submitted,

D. O. NOURSE.

REPORT OF BOTANIST AND BACTERIOLOGIST.

Clemson College, S. C., June 30, 1908.

Prof. J. N. Harper, Director, S. C. Experiment Station.

Dear Sir: I beg leave to submit the following report of the Botanical Division of the Experiment Station for the year ending June 30, 1908:

The teaching for this division in the College and Station has been unusually heavy for this year. The number of hours of actual teaching each week was 23, 27 and 33 for the first, second and third terms, respectively. Aside from these regular hours of teaching the collection and preparation of material for laboratory and class-room work has taken considerable time and attention.

The correspondence of the office has been as large as usual.

The identification of various plants and plant diseases, which have been sent in from time to time, has been carefully looked after and much information has been given out in this way by personal letters. At the suggestion of the Director some preliminary work has been undertaken in connection with the rot-producing organisms of sweet potatoes. In this some interesting things have developed in reference to the prevalence of certain species of fungi which cause these rots and in the way of rot-producing organisms which seem to have been previously overlooked. In case this investigation is continued by the Station next year it is to be hoped that there will be more time available for making a complete study of these fungi and their effect on sweet potatoes in storage.

As an Adams Fund project some study of cotton anthracnose has been undertaken. A plan for making further investigations of the life history of the organism and of its method of infection was drawn up and submitted to the office soon after the present incumbent took up the work here last September. This was approved by the Office of Experiment Stations, but no money was appropriated by the committee here for carrying the plan into effect until late in March. At this time the writer was carrying thirty-three hours of teaching a week and had no time for investigation. This is a piece of work that is very interesting from a scientific as well as important from a practical standpoint. Nothing has been done on it within the

past few years and there is good reason to believe that with modern methods and concentrated effort something new can be learned in reference to the life history of the fungus and its method of gaining entrance into the plant. This investigation will be continued with renewed energy after July 1st, and it is to be hoped that this summer will afford good opportunity for obtaining important data in reference to the fungus (Colileto trichrum gossyppi) and its habits.

With the complete separation of the Station and College Divisions of Botany, which takes place July 1st, the Station Botanist will have more time to devote to this kind of work.

Respectfully submitted,

HENRY W. BARRE,
Botanist and Bacteriologist.

REPORT OF VETERINARIAN.

Clemson College, S. C., June 30, 1908.

Prof. J. N. Harper, Director, S. C. Experiment Station, Clemson College, S. C.

Dear Sir: I have the honor to submit the following report of the work of the Veterinary Division of the Experiment Station for the fiscal year ending June 30, 1908:

During the past year the duties of this office have been greatly increased by the additional work of tick eradication, now being conducted by this State in cooperation with the Bureau of Animal Industry, and for this reason it has been impossible to devote sufficient time to Station work.

On taking charge of the Division in September, 1907, I found experiments in progress to determine the most practical method of eradicating stomach worms from infested pastures. Funds were also available for investigating the relation of cotton seed meal feeding to barrenness, abortion and diseases of the udders of milch cows.

Stomach Worm Experiment.

A series of experiments to determine the most practical method of freeing pastures from this parasite has been in progress for some time and will be continued until fall. Several important facts have been determined by these experiments and the control of the disease will consequently be facilitated.

The efficacy of drugs usually administered for the destruction of this parasite has also been investigated and the results emphasize the importance of preventive measures rather than medical treatment.

Stomach worms (Strongylus contortus) cause severe losses among the sheep and young cattle of this State, especially during the wet seasons, when conditions are favorable for the development of the parasite. Similar losses are reported in many States, and it is important that this investigation should be continued by a veterinarian in the employ of this Station until a satisfactory method for the control of this parasite is discovered.

During the past year the study of this problem has been complicated by the introduction of the hook worm (Uncinaria radiata), a common parasite throughout the South, but one that has not appeared before at this Station.

Cotton Seed Meal Experiment.

As the study of this problem would demand more attention and time than could be given without neglect of College and State work, it was decided, after consultation with the Director, to postpone these investigations until more time was available for their continuation.

This is another problem of vital interest to farmers in the South, and one that can only be undertaken by a veterinarian. Owing to the fact that there are so many important problems that cannot be investigated without the aid of a veterinarian, it is to be regretted that this Station will have no veterinarian on its staff in the future.

Oxygen Treatment for Milk Fever.

A description of this disease and a record of successful application of the oxygen treatment at this Station has been published as Bulletin No. 139.

Very respectfully,

M. RAY POWERS,
Veterinarian.

REPORT OF ZOOLOGIST AND ENTOMOLOGIST

Clemson College, S. C., December 7, 1908.

Prof. J. N. Harper, Director, S. C. Experiment Station.

Dear Sir: I herewith submit my report of the Division of Zoology for the fiscal year ending June 30, 1908. The writer began his duties October 11, 1907, and as there were no records of the work of the Division, there could be no continuation of problems already begun. This was unfortunate, because under these conditions unnecessary repetition could not be avoided.

Stomach Worm Investigations.

Although you requested that this should be the principal investigation in this Division, owing to the approach of cold weather, when the Zoologist began his duties here, this work could not be carried on in a very satisfactory manner. On account of the continual presence of other notorious parasites which were at that time causing the principal loss to the cattle of the College farm, the Zoologist, with your permission, interpreted the investigation to include those parasites, and the investigation was prosecuted vigorously during the entire winter and spring. The parasites included in this work were stomach worm (H. contortus), hook worm (M. phlebotomus), hair worm (C. punctata), and the inflated bowel worm (A. inflatum). These species are all parasites of the alimentary canal of cattle, and are distributed principally as follows: Stomach worm in the pyloric region of the fourth stomach; hook worm and hair worm in the upper portion of the duodenum, while the inflated bowel worm occurs in the cæcum. Of these parasites mentioned the first three alone seem to have any economic importance, while the hook worm has been the chief, if not the sole, cause of the death of animals at this Station during the past winter and spring. (This does not refer to the epidemic outbreak occurring among the young cattle on the College farm during the last week in April.) While the work on stomach worm was carried on as thoroughly as possible our principal attention was directed to the hook worm. M. phlebotomus and Cooperia punctata have received little attention by American investigators, and owing to the originality of most of the work done on these parasites, as well as the fact that they were not reported from

South Carolina before, these preliminary investigations have already been published in Bulletin 137 of this Station.

While the investigation has been planned to cover almost every conceivable phase of the subject, it must be remembered that the problem is a tremedous one, and with the meager working power we have at the present time, it is necessary to take it up in sections. The principal experiment in progress at the present time is to determine some practical method for eliminating the serious effects of infestation in the animal by grazing on pasture presenting definite conditions. The project is an extensive one, but suffice it to say that lots have been prepared at the College farm where the best conditions exist for this experiment. The animals used in this experiment belong to the College farm and are furnished by Mr. J. P. Lewis, the farm superintendent. Whatever results are obtained will apply to all of the parasites mentioned above.

Other Investigations.

Owing to the meager records of South Carolina insects it is necessary to work out certain points about our common insects in order to enable us to give reliable and practical information to the correspondents of this Division. These investigations may be briefly summarized as follows:

Peachtree Borer.—In order to control this insect in the most rational manner, it is necessary to know as nearly as possible the pupation period. Fortunately we have the careful records of Prof. C. C. Newman, who studied this insect through one season a number of years ago. It is desirable, however, to repeat this work several seasons, because this insect, like most other species, is responsive to climatic conditions.

Codling Moth.—There are no records of the broods of the codling moth for South Carolina. A knowledge of this point is absolutely essential for the successful control of this insect. This work is in progress and has been carried on by two senior students, Messrs. Gee and Baker.

Plum Curculio.—This insect has long been known as a fruit pest, but it is only in recent years that it has adopted the peach extensively as a food plant in the South. Regarding its control on peach there is nothing definitely known. Preliminary to contemplated work on this subject, we are for the first time studying the life history for South Carolina. Besides the biologic work, close attention is given to the parasites that destroy the larva. These several inves-

tigations are in progress and will be continued through the year, if possible.

Pecan Insects.—A study of pecan insects has been begun and will be continued as far as time permits. A study of the burrowing habits of the pecan trunk borer has been made and the life history partly determined. Although common, this is not a serious pest to control.

Collections.

A collection of South Carolina insects has been begun. The specimens are mounted in a large case fitted with Cornell drawers. This work will be continued and lists with records of distribution and injury will be presented for publication during the coming year.

Correspondence.

The correspondence of this Division has been much lighter than it should be. There is a continual increase at the present time, owing to the arrival of the crop season. The correspondence work has been organized in a manner that inquiries can be answered promptly and at the same time all records filed in such a way so as to make them easily accessible by almost any conceivable means of cross reference. The system consists of correspondence cards, accession cards, food catalog and species catalog. To this will be added distribution maps, which will enable us to keep a record of the distribution and injuries by various insects from year to year.

Publications.

Besides seven newspaper articles this Division has issued two bulletins during the past year, viz., Bulletin 134, San Jose Scale, and Bulletin 137, Hook Worm Disease in Cattle. The latter bulletin was issued jointly with the Division of Veterinary Science.

Work Proposed for the Coming Year.

I recommend that the work for the coming year will be a continuation of the work now in progress. Our chief attention will be directed to a study of the strongyloid parasites in the digestive tract of ruminants. This investigation is at present prosecuted vigorously, and the economic results will be published next fall as a continuation of the preliminary investigations already recorded in Bulletin 137 of this Station. There is considerable technical work accumulating in connection with this investigation which could not be published to advantage in a farmers' bulletin, but which could be

presented from this Station in a technical bulletin in a smaller issue.

It is the aim of this Division to prosecute one single investigation, giving it all the attention it requires, and utilizing odd moments in carrying on such phases of the other investigations suggested as far as possible.

While this report is being written arrangements are under way for cooperative work with the U. S. Department of Agriculture. An investigator of the Bureau of Entomology is stationed at this laboratory cooperating with this Division in the investigation of insects injurious to cereal and forage crops. At the present time the Southern grain louse is receiving the principal attention. While this insect is one of the most serious pests in Southern agriculture we have no records of any work done with it in South Carolina. Furthermore, owing to the total absence of records, there is an endless amount of work to be done in this State, even on the more common insects. Cooperative work with the Department of Agriculture on South Carolina insects if carried on judiciously is, therefore, desirable, especially when considering the small working force in this Division at the present time.

Thanking you for your interest and courteous support, I am

Respectfully yours,

A. F. CONRADI,
Zoologist and Entomologist.

REPORT OF SECRETARY AND LIBRARIAN.

Clemson College, S. C., November 25, 1908.

Prof. J. N. Harper, Director, South Carolina Experiment Station.

Dear Sir: Responding to your request, I beg to submit the following report of a part of the work performed in the office of the Secretary and Librarian of the South Carolina Experiment Station, for the period of the fiscal year, beginning July 1, 1907, and closing June 30, 1908:

The activity and success of this office in bringing the results of the Station's work before the agricultural public continue unabated as the work becomes more important and more necessary to the welfare of the farmers of the State. Nothing so readily gives practical value and general importance to Experiment Station work as an extended dissemination of the reports of its progress and accomplishment, in the solution of agricultural problems.

The remarkable success, which has attended the wide distribution of our publications throughout the State, and even into the regions beyond, is clearly to be seen in the employment by our farmers of better methods for cultivating, fertilizing, harvesting and marketing their crops,—in the more reasonable provision for the caring and feeding of farm animals, and in the more successful application of remedies for diseases of plants and animals.

This Experiment Station has issued during the past year nine bulletins and one annual report. These contain in the aggregate 268 pages. Besides the analyses of commercial fertilizers, these bulletins represent intelligent discussions on quite a variety of interesting subjects, such as: "Rotundifolia Grapes," "Report of Coast Land Experiments," "The San Jose Scale," "The Williamson Plan in 1907," "The Manufacture of Starch from Sweet Potatoes," "Hook Worm Disease of Cattle," "Milk Fever—Its Prevention and Successful Treatment," and "Some Conditions Influencing Cotton Production."

The work of distributing the analyses of commercial fertilizers among the farmers of this State was begun in the month of January. A leaflet of four pages containing the analyses was published at the College and mailed from this office once a week for twenty-two weeks in editions of 14,000 copies. These leaflets were distributed with weekly regularity upon as many farms in the State. The pur-

pose of this wide diffusion of the records of the chemical analyses was the protection of the farmer against the purchase of fraudulent fertilizers.

The total number of bulletins issued from this Station during the past fiscal year, including the fertilizer leaflets, amounted to 404,000 copies.

A striking evidence of a growing interest in all matters pertaining to the publications of this Station is seen in a statement of the fact that we have made accessions of 1,600 names on the permanent mailing list, within the past year.

Respectfully submitted,

JOHN N. HOOK,
Secretary and Librarian.

LIBRARY
OF THE
UNIVERSITY OF ILLINOIS
23 APR 1915

TWENTY-SECOND ANNUAL REPORT

OF THE

South Carolina Experiment Station

OF THE

Clemson Agricultural College

FOR THE YEAR ENDING

JUNE 30, 1909.

CLEMSON PRINTERY

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C. C. Newman, B. S., *Horticulture.*

H. W. Barre, B. S., *Botany and Plant Pathology.*

A. F. Conradi, B. Agr., M. S., *Entomology and Zoology.*

Thos. E. Keitt, B. S., *Chemistry.*

E. Barnett, V. M. D., *Animal Husbandry and Veterinary Science.*

John N. Hook, *Secretary and Librarian.*

W. D. Garrison, B. S., *Superintendent Coast Experiment Station.*

Burns Gillison, *Foreman of Station Farm.*

Miss Helen Bradford, *Stenographer.*

Mail and Telegraph: Clemson, S. C.

Freight and express: Calhoun, S. C.

The Bulletins of the Station are issued at irregular intervals, and are sent free to all citizens of the State who apply for them.

Letter of Transmittal.

Clemson College, S. C., November 20, 1909.

Hon. M. F. Ansel, Governor of South Carolina.

Sir: I have the honor to submit herewith the Twenty-second Annual Report of the South Carolina Agricultural Experiment Station, in accordance with the requirements of an Act of Congress, approved March 2, 1887, for the establishment of Agricultural Experiment Stations in connection with the colleges of the several States, organized under the provisions of an Act approved July 2, 1862.

Respectfully submitted,

P. H. MELL, President.

REPORT OF DIRECTOR.

Clemson College, S. C., July 5, 1909.

Dr. P. H. Mell, President, Clemson College, S. C.

Dear sir: I have the honor of submitting herewith the twenty-second annual report of the South Carolina Experiment Station for the fiscal year ending June 30th, 1909.

This has been by far the most prosperous year in the history of the Experiment Station. The Station has a splendid corps of scientists and workers who are doing their utmost to make a name for themselves and to achieve a creditable success. Every member of the Staff is using his best efforts to contribute his part in the solution of the many problems confronting the farmers. In planning our experiments we have but one object in view, and that is how we can best promote the welfare and progress of the farmers of the State. It is our endeavor to work on those fundamental problems, the solution of which will be of the greatest practical value.

The Station is becoming more and more appreciated each year by the agricultural communities of this and adjoining States. During the year fifteen hundred additional names, by request, were added to our mailing list. As heretofore the number of letters received by the various members of the Staff from farmers residing in this State who desire information along the various lines in which they are engaged, amounted to thousands. This is one of the most important features of our work because it brings the Station workers in direct contact with the farmers and we are thereby made more fully acquainted with the problems needing our attention. The Station stenographer, with assistance given her by Prof. Conradi, has devised a card system for recording all letters in such a way that they can be referred to instantly by subject or by name. In this report I wish to commend most heartily Miss Bradford, who is not only a splendid stenographer, but a capable secretary and assistant as well.

During the fiscal year the Station made an exhibit at the State Fair which represented to the people of the State in a practical way the main features of the work of the Station. This exhibit

was a part of the general exhibit made by Clemson College. All of the Divisions of the Station were represented in this exhibit. The State Fair authorities expressed their appreciation of the efforts we put forth in getting up this exhibit. The Director of the Station was elected to a membership on the Executive Committee and placed in charge of a department of the State Fair Association.

The members of the Station Staff have also assisted in conducting Farmers' Institutes in the State and during the year the Director accepted invitations to lecture to farmers at a number of places. They have also taken an active interest in the work and meetings of the South Carolina Live Stock Association and have contributed to it their time and support.

The Station continues to co-operate with the U. S. Department of Agriculture in experimental work. The Agricultural Division is co-operating with the Bureau of Plant Industry in testing a number of forage plants, the seed of which are from various States and from different countries; also in breeding sweet corn. This sweet corn work has now continued uninterruptedly for five years. The Government experts in charge of this work report that the sweet corn grown at our Experiment Station contains more sugar than was obtained from the same variety grown in any other place in the country.

The Division of Entomology continues its co-operative work with the Bureau of Entomology with the cereal and forage crop insects.

The Division of Botany is co-operating with the Bureau of Plant Industry in making a plant disease survey of the State, and with the Bureau of Forestry in testing methods of preserving timber with creosote.

The Division of Animal Husbandry and Veterinary Science is co-operating with the bureau of Animal Industry in its work with the hog cholera serum. The Dairy Division of the same Bureau has done considerable work in our State for some time in developing the dairy industry. This Station is now co-operating with this Division, and elsewhere in my report I recommend that this be made co-operative work and that the Station pay a portion of the salary of the dairy expert in charge of the work in this State.

Recently the Director of the Office of Experiment Stations, U. S. Department of Agriculture, notified this Station that in the future the publication of no bulletin can be paid for out of the Hatch Fund, excepting those which give the result of experiments performed under the Hatch Act. This restricts the publication of all bulletins of a popular nature or compiled bulletins to our fund known as the sale of farm products. It has also been ruled by the same office that the Hatch Fund cannot be used for demonstration work, for farmers' institute work, or for the support and maintenance of branch experiment stations. During the past year we have met all requirements of the Office of Experiment Stations in the restrictions it has placed around the Adams Fund. In the past month the Director has had correspondence with authorities in the Office of Experiment Stations in which he presented all the projects that are now being conducted under the Adams Fund, together with a financial statement of the same. All of these projects have been approved by the Washington authorities and they are as follows:

Project No. 1, Division of Entomology and Zoology,—Life history and action of the stomach worm. This problem has been enlarged somewhat because of the close relationship of this stomach worm to other parasites of the intestinal tract of ruminants. This problem would better be designed as follows: The investigation of strongyloid parasites.

Project No. 2, Division of Entomology and Zoology,—Temperature in its relation to insect activity.

Project No. 3, Division of Veterinary Science and Animal Husbandry,—Contagious abortion in cattle, cause and dissemination.

Project No. 4, Division of Veterinary Science and Animal Husbandry,—Physiological and pathological effect of feeding heavy amounts of cotton seed meal to cows.

Project No. 5, Division of Veterinary Science and Animal Husbandry,—An experiment to determine the cause of cotton seed meal poisoning in hogs and its relation to abortion in cattle. This experiment is to be in co-operation with the Chemical Division. The following is an outline of the experiment:

(a.) Extracts by means of various solvents.

(b) Feeding or inoculating small animals with extracts.

(c) Experiments on domestic animals.

(d) Pathological and histological examination of organs of animals so treated.

(e) Attempt to isolate the active principle.

The Division of Veterinary Science and Animal Husbandry is also working in co-operation with the Division of Entomology and Zoology on the hook-worm disease of cattle and sheep. The outline of the work on this problem by this Division is as follows:

(a) Blood examinations to determine the effect of this disease on the Haemaglobin content, red corpuscles and proportions of the various Leucocytes.

(b) Inoculation experiments with blood to determine if disease can be transmitted in this manner.

(c) Feeding living larvae to determine the exact condition under which infestation results in the stomach and intestines.

Project No. 6, Agricultural Division,—Effect of pollen from barren stalks of corn. Last year hundreds of plants were hand pollenized and the silk was protected by careful means to prevent any crossing. A large field is planted this year from the result of last year's crosses.

Project No. 7, Agricultural Division,—Relation between soil and length of staple of cotton. This experiment is being continued. We are sending out a great number of samples of cotton of two or three varieties and having these grown in different sections of the State under conditions as near alike as possible. Samples of cotton grown from these seed will be sent to us from various sections of the State, together with samples of the soil and the cotton will be graded and judged by our Textile Department.

Project No. 8, Horticultural Division,—Experiments to determine the effect of foreign pollen on the productiveness of varieties of Rotundifolia grape.

Project No. 9, Division of Botany and Plant Pathology,—A study of the life history of the fungus which causes anthracnose of cotton and experiments relative to controlling the same. During the past year Prof. Barre has devoted his time almost wholly to this one experiment. Prof. Barre states that thus far he has found that the fungus which causes anthracnose lives through

the winter in a conidial stage and is alive in that stage up until May 26th. He further states that he has also found that when seed from infested fields are germinated anthacnose occurs on the seedlings. So far the perfect stage of the fungus has not been found in nature. In continuing the work the following points will be considered:

(a) Whether the fungus penetrates the tissue of the seed and the embryo or not, and if so whether treatment of affected seed with solutions, such as mercuric chloride or copper sulphate, will kill the fungus without injuring the seed.

(b) The determination, if possible, of the time and method of infection of the bolls.

(c) Testing the progeny of diseased stalks and stalks free from disease in badly diseased cotton fields so as to get a line on the possibility of breeding a strain of cotton which would be resistant to anthracnose.

(d) The continuation of the life history of the fungus.

During this fiscal year this Station has published six bulletins as follows

No. 141, "Treatment of Plant Diseases and Injurious Insects in South Carolina."

No. 142, "Stomach Worm Disease of Sheep and Young Cattle."

No. 143, "Some Injurious Orchard Insects."

No. 144, "Celery."

No. 145, "Fertilizer Experiments with Cotton."

No. 146, "Sweet Potato Work in 1908."

Aside from this, this Station paid for Bulletin No. 138 which was issued by the Chemical Department giving the results of the analyses of commercial fertilizers.

The experiments of the Agricultural Division being conducted under the Hatch Fund are as follows:

1. Experiments to determine the most economical fertilizer to be used on the uplands of South Carolina for the various staple crops and the proportions of various ingredients that make up these fertilizers for these different crops when grown in proper rotation. These experiments have been in progress for four years and the result for three years' work has been published in Bulletin No. 145.

2. Experiments to determine the best paying system of crop rotation with the view of keeping up the fertility of the soil, cotton being one of the main crops in the rotation.

Experiments to determine the best variety of cotton suited to the different soil types of the State. In this experiment we are co-operating with quite a number of farmers living in different sections of the State. We sent two or three varieties to each farmer co-operating with us. Considerable interest is being shown in this experiment, and the data that we are obtaining will be of great pratical value.

4. The growing of cotton with the view of increasing the yield, length and quality of the fibre, increasing the size of the boll and the general vigor of the plant. Two years ago we made about four hundred crosses, using twenty-five or thirty varieties of known merit. The seed of these crosses were grown last year in plots and selections were made from the most promising plants. As a result of these we have sixty new varieties now growing on our Experiment Station grounds. One of the most promising is an early type of cotton which appeared in a field of Black Seeded Blue Ribbon. This variety appears to be resistant to disease.

5. The breeding of corn with the view of increasing the size and uniformity of the ear and increasing the yield of the grain, also to obtain a stronger stalk with short internodes. We began this experiment by testing a number of varieties obtained through the U. S. Department of Agriculture, and from these experiments we have come to the conclusion that for the upland soils the prolific varieties are the best. We obtained a type of corn in Chesterfield County from Mr. David McGregor. This corn has been grown in that county for some time and is well known there as quite a prolific variety. We are improving it by careful selection. We saved our seed from stalks only that had two to three good vigorous ears. This variety of corn has some objectionable features which we hope to eliminate by careful breeding. We are also crossing this with a splendid type of corn known as Lee corn obtained in Marion County.

6. Experiments to determine the relative value of lime nitrogen, nitrate of soda, sulphate of ammonia and cotton seed meal as a source for ammonia to be used as a top dressing for

cotton, corn, oats and wheat.

7. Experiments to determine the best time to apply nitrate of soda as a top dressing to cotton, corn and oats. We have considerable data from this experiment and will publish a bulletin at an early date giving to the farmers the results obtained.

8. Experiments with the Williamson Plan of growing corn and modifications of this method.

9. The testing of various forage crops and cereals, such as German millet, oats, wheat, sorghum, rye, barley, red clover, bur clover, soy beans, crimson clover, vetch, cowpeas and beggar weed.

10. Experiments to determine the best time to apply phosphoric acid and potash to oats. In this experiment we have a number of plots that we fertilized in the fall when the oats were sown, and applied later nitrate of soda the middle of April. To other plots were applied half of the fertilizer in the fall when the oats were sown and the other half the middle of March, and later an application of nitrate of soda. Our results thus far show that it pays to apply in the Spring acid phosphate, potash and cotton seed meal in addition to the previous applications at the time of planting in the Autumn.

11. Variety test of wheat, corn, alfalfa, cowpeas, sweet potatoes. In this experiment we have tested seven varieties of wheat, seed of which we obtained from the Kentucky Experiment Station, four years ago. One of these known as Pootung, a variety which the Kentucky Station obtained from China about ten years ago, has proven to be a good yielder on our soils.

We are testing thirty varieties of alfalfa, the seed of which we obtained from the U. S. Department of Agriculture. These alfalfa seed came from different sections of this country and from a number of foreign countries. These experiments show that the successful growing of alfalfa is largely dependent upon the source from which seed have been obtained. Alfalfa seed from Texas, New Mexico and Arizona produce plants that make a vigorous growth, but the winter freezes kill them. In every case where the seed were obtained from the northwestern States, vigorous plants were obtained and our notes show that not a single plant was killed by the late frosts in April.

Formerly, this Station has been testing a great number of

varieties of cowpeas, but now we have limited them only to those varieties that have proven of merit.

The object of the variety work with sweet potatoes has been to obtain a high yielder and one valuable for starch production.

12. Experiments with different methods of sowing oats and at different times.

13. Experiments in sowing alfalfa at different times of the year by different methods. From these experiments we have found that the fall sowing is by far the best time and that alfalfa should be sown broadcast, sowing a large amount of seed to obtain a perfect stand.

14. Fertilizer experiments with alfalfa. The data obtained from these experiments show that at the time alfalfa is sown it should be heavily fertilized with acid phosphate, potash and a soluble nitrate. We have an alfalfa field that is now four years old. This Spring this field was divided off into plots, and phosphoric acid, potash and nitrate of soda and combinations of these elements were applied to different plots. No difference could be noted this year between the different plots fertilized and the check plots receiving no fertilizer. To grow alfalfa successfully on these soils it is absolutely necessary to apply lime at the rate of 1000 or 2000 lbs. per acre and this lime should be applied at the time of preparing the land before the alfalfa seed are sown.

15. Experiments to determine the value of alfalfa by growing a previous crop of bur clover as compared with the artificial methods of inoculation.

16. Experiments to determine the best legumes to plant in cotton, bur clover, vetch and crimson clover being the crops used.

17. The study of the fertility of the soil as influenced by its physical condition.

18. Notes on the various grasses most suitable for holding terrace banks.

19. Notes on the cross breeding of horses, the German Coach and the Standard bred horses being the types of horses used.

20. Experiments to determine the best form in which to apply phosphoric acid to our type of soils. In this experiment we are comparing the relative value of floats of ground phosphate rock as compared with acid phosphate, and we are also testing

the relative value of germofert as compared with a complete fertilizer containing the same amount of phosphorous in the form of acid phosphate.

Full reports of the work of the other Divisions of this Station are appended.

The Experiment Station occupies a unique position among the factors that stand for development and progress in our State. Its main function is to search for and bring to light truth, the knowledge of which will make for material enrichment. For that reason the Station must necessarily be conservative. In its work it does not overlap or conflict with, but is in hearty co-operation with the other departments of endeavor in the State at work for the upbuilding of our commonwealth, such as the U. S. Department of Agriculture, the State Fair Association, the Farm Demonstration work, the Farmers' Institute work, the Agricultural Department of our College, and the State Department of Agriculture and Commerce.

In conclusion, I wish to express to you my great appreciation of the kind personal, as well as the official interest you have always shown in our work.

J. N. HARPER,
Director.

SOUTH CAROLINA AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH THE UNITED STATES APPROPRIATION, 1908-1909.

Debtor.		Hatch Fund.	Adams Fund.
To receipts from the Treasurer of the United States, as per appropriations for fiscal year ended June 30, 1909, under acts of Congress approved March 2, 1887 (Hatch Fund), and March 16, 1906 (Adams Fund)		$15,000 00	$11,000 00
Credit	**Abstract.**		
By Salaries	1	7,356 25	7,175 00
Labor	2	1,480 84	2,284 35
Publications	3	1,210 20	

Postage and stationery	4	173 99	73 56
Freight and express	5	251 32	27 68
Heat, light, water and power	6	80 05	
Chemical supplies	7	455 97	22 97
Seeds, plants and sundry supplies	8	696 31	176 49
Fertilizers	9	450 18	304 16
Feeding stuffs	10	1,315 93	480 55
Library	11	117 41	
Tools, implements and machinery	12	232 41	64 69
Furniture and fixtures	13	403 70	
Scientific apparatus	14	17 20	157 47
Live stock	15	58 60	115 00
Traveling expenses	16	217 76	31 15
Contingent expenses	17	33 30	
Buildings and land	18	448 58	86 93
Total		$15,000 00	$11,000 00

We, the undersigned, duly appointed Auditors of the Corporation, do hereby certify that we have examined the books and accounts of the Treasurer, South Carolina Agricultural Experiment Station for the fiscal year ended June 30, 1909; that we have found the same well kept and classified as above; that the receipt for the year from the Treasurer of the United States are shown to have been $15,000 under the act of Congress of March 2, 1887, and $11,000 under the act of Congress of March 16, 1906, and the corresponding disbursements $15,000 and $11,000; for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving balances of $..... and $.....

And we further certify that the expenditures have been solely for the purposes set forth in the acts of Congress approved March 2, 1887, and March 16, and in accordance with the terms of said acts, respectfully.

(Signed) R. W. SIMPSON,
Chairman, Finance Committee, Auditors.

Attest: P. H. E. SLOAN, Custodian.

SOUTH CAROLINA AGRICULTURAL EXPERIMENT STATION, 1908-1909.

(Supplementary Statement.)

(This supplementary statement, while not required by law, is desired as an aid in interpreting the account rendered for the United States appropriation. While it will be more useful if made in conformity with the schedule fixed for that appropriation, if this is not practicable such a summary of receipt and expenditures from the sources indicated below as can be conveniently prepared from the books of the station may be substituted. Whenever practicable, it should be for the fiscal year ended June 30.)

Debtor.

To balance on hand July 1, 1908	$2,101 07	
Receipts from other sources than the United States for the year ended June 30, 1907	2,976 11	
Total		$5,077.18

Credit.

By Salaries	$ 668 74	
Labor	25	
Publications	443 70	
Postage and stationery	10 72	
Freight and express	60 49	
Heat, light, water and power	74 53	
Chemical supplies	15 90	
Seeds, plants, and sundry supplies	104 07	
Fertilizers	4 76	
Feeding stuffs	17 23	
Library	12 00	
Tools, implements and machinery	11 90	
Furniture and fixtures	30 00	
Scientific apparatus	24 30	
Live stock	6 00	
Traveling expenses	40 95	
Contingent expenses	18 70	

Buildings and land	323 93	$1,868 17
Balance		$3,209 01

Clemson College, S. C., July 1, 1909.

Prof. J. N. Harper, Director, S. C. Experiment Station.

Dear Sir: I respectfully submit the following report of the Horticultural Division of the South Carolina Experiment Station for the year ending June 30th, 1909:

On account of the change in the location of the horticultural grounds last June, the work of this Division has been largely preparatory for future experiment work. The land selected for the Horticultural Division is located west of the Agricultural Experiment grounds. One-half of this land was in original forest, the other half in wornout hillsides. We began clearing the woodland last September and the greater portion of this land is now in condition for planting. The hill land which has been in cultivation for a number of years has been set in fruit trees. On account of this land being in a very much run down condition, it will be necessary for us to use every means possible to improve the condition of the soil in order that we may produce a good vigorous growth of trees. The field where the orchard is located is well suited for the growing of peaches, plums, pears and apples. The peach orchard is planted on the top of this hill, which is one of the highest points on the experiment grounds and the fruit will rarely be killed by frosts on account of the elevation. The apples and pears are planted on the northern and western slopes. The plum orchard will be planted on the southern and eastern slopes this fall. I have endeavored to get all of the permanent crops established as soon as possible, and by the last of December we hope to have practically all of the tree fruits planted. The trees that were planted last Spring have all made a very good growth considering the character of the soil.

The new land where the truck and small fruit experiments will be conducted is now being prepared for planting and we hope to have this land in good condition by the last of December. The land will hardly be in condition, however, for truck experiments until the Spring of 1911.

Our grape vineyard has been planted on new ground that was cleared of stumps last fall. These vines have made a remarkable growth considering the condition of the land. Our experiments with the Rotundifolia grapes have been continued and during the past season over 1000 crosses were made. The seeds of these crosses will be planted this fall. We already have underway about 1200 seedlings, the results of crosses made two years ago. These vines have been planted to the field and every effort will be made to bring them to bearing as early as possible. On account of the change of location in the horticultural grounds, many of our experiments that were underway have been discontinued. The experiments with peaches, apples, pecans and grapes will be continued in the old horticultural grounds for two or three years until our records of these fruits have been completed. The professor of Horticulture has kindly consented to allow me to use such trees and vines in the horticultural grounds as we may need for experiment purposes as long as we may need them.

During the past season a horticultural house has been erected on the grounds. This building consists of a one-story frame house containing five rooms. A portion of this building will be used by the Station botanist and entomologist until it is all needed by the Horticultural Division. One room of this house is used as a record room. There is a seed room, 8 x 10 feet; a room for storing chemicals, 8 x 10 feet; a large tool and implement room, 25 x 30 feet; and a small fertilizer house and implement shed have also been erected.

The results of our experiments for the last few years are being put in shape for publication. I have material practically ready for the publication of bulletins on at least half a dozen subjects. These will be presented whenever they are called for.

Very respectfully,

C. C. NEWMAN,
Horticulturist.

Clemson College, S. C., July 1, 1909.

Prof. J. N. Harper, Director, S. C. Experiment Station.

Dear Sir: The following is a summary of the work done

in the Botanical Division of the Experiment Station during the fiscal year ending July 1, 1909.

My time during the past year has been devoted to three lines of work as follows: Study of cotton anthracnose, study of sweet potato rots, general survey of plant diseases present in the State. A summary is here given of the work with sweet potatoes and the plant disease survey and an article giving the preliminary report of the cotton anthracnose investigation.

Sweet Potato Rots.

The study of the sweet potato rots has been continued during the year with a number of interesting results. Six different fungi which cause rots of sweet potatoes have been isolated and studied in pure cultures. These are species of Rhizopus, Mucor, Fusarium, Nectria, Penicillium and Ceratocystis. The most interesting thing found in this study so far is the fact that none of these organisms will produce rots except under certain conditions. Inoculations with these fungi had no effect on the potatoes kept at laboratory temperature unless they had been previously injured in some way. If individual potatoes which were inoculated were placed out on the window sill for a few hours during cold weather and allowed to become thoroughly chilled, the fungi would then take hold and destroy them. This was especially true of Rhizopus. It seems, therefore, that the rotting of sweet potatoes is largely physiological and that where potatoes are kept at the right temperature and where the ventilation is good they should keep indefinitely. These experiments will be contained in the coming fall and winter and a storage house will be erected in which temperature and humidity can be controlled.

Potatoes were also treated with copper sulphate, mercuric chloride and formalin solutions and stored in banks in the usual way. The results from such treatment were very unsatisfactory. The checks seemed to keep as well as the treated potatoes. Individual potatoes were also treated in the laboratory and stored in various ways in contact with diseased potatoes but no definite conclusions have yet been reached with these.

Plant Disease Survey.

In co-operation with the Bureau of Plant Industry we are making an effort to determine just what plant diseases occur

in the State and in what portion of the State each disease is found. So far we have collected and had sent in 102 different bacterial and fungus diseases of plants. Some of these, such as pear blight, apple rust, grain rust, cotton anthracnose and rose mildew occur all over the State, while others, like wilts of cotton, peas and watermelons occur only in certain sections, and, still others, have been reported from only one or two localities. By means of maps printed on the cards used in disease survey catalog, we can tell at a glance from just what section of the State a certain disease has been reported and on whose farm it occurs. When this survey is completed we will be able to tell just what diseases occur in any county in the State, and by means of circular letters and press bulletins can advise people how and when to treat each disease. A plant disease herbarium is being kept in connection with this survey so that in the future we expect to have on file specimens of every disease that occurs within the State.

Publications.

Bulletin No. 141, "Treatment of Plant Diseases and Injurious Insects in South Carolina," has been issued in conjunction with Prof. Conradi. Aside from this a number of newspaper articles on various plant diseases have been sent out from time to time.

Correspondence.

The correspondence of the Division has continued to increase since the Station has been separated from the College and more time is available for this kind of work. A large part of this increase has been in connection with the plant disease survey and with the investigation in connection with cotton anthracnose. Over a hundred plants of various kinds have been sent in for identification from time to time. A small number of samples of grass and clover seed have been sent in for analyses. This phase of the work should be encouraged and if possible more time given to it because there is probably more fraud practiced in the selling of grass and clover seed to farmers than in any other one thing along this line.

Respectfully,

H. W. BARRE,
Botanist.

Clemson College, S. C., July 1, 1909

Prof. J. N. Harper, Director, S. C. Experiment Station.

Dear Sir: I submit the following report of the Division of Zoology for the fiscal year ending June 30th, 1909. This report is brief because a full discussion of the various phases of the work will appear as separate articles in the annual report of this Station for this year. The work of this year has been chiefly a continuation of the work of the previous year.

Investigation of Strongyloid Parasites of the Digestive Tract of Ruminants.

The stomach worm investigation was in progress when the writer took charge of this division, but owing to the total absence of records the time devoted to it previous to October 11, 1907 was lost. It must be understood that the problem under consideration this year was begun October 11, 1907 and has now been in progress about one year and a half. During this period there has been continuous co-operation between the Divisions of Veterinary Science and Zoology. The life history of the stomach and hook worms were worked out and pasture methods experimented with. A careful study of the infestation thoroughout the year made it appear that the death of the animal is not proportionate to the degree of infestation, and furthermore that the worms are not the direct cause of sickness and death. In view of these suppositions, the principal attention will be given to the probable occurrence of other causes. A full discussion of this subject as well as a record of other worms studied will be found in another portion of this report.

While this was the principal investigation, a few minor entomological investigations were carried on. A careful study of the life history of the peachtree borer was made during the past season at Clemson College and vicinity, and although this is partially reported in Bulletin 143 of this Station, a full discussion with diagramatic references will be found in another portion of this report. A study of the other insects mentioned has been continued, but owing to the meager time available, little progress has been made. The season for codling moth was so unfavorable last year that no results were obtained.

One of the principal insect investigations of the division dur-

ing the past season was that of the cotton root louse which is in progress at the present time and which will continue throughout next season. It has been definitely determined that this insect is the same as the corn root louse, and a careful study of the food plants and host plants has been made. Up to the present time there have been discovered upwards of twenty-six food plants besides the cotton on which this insect can live. A full report of this will be found in another part of this annual report.

A few bees, located at the Station farm, were put in charge of this Division, but owing to lack of funds with which to begin the operation of this apiary in a proper manner, our study of apiculture was confined to the study of honey plants of the season and locality. This section gives promise of being a good honey section. In looking over the census report for South Carolina for 1900, we find the following conditions: Swarms, 93,958; value of bees, $142,677; pounds of honey produced, 872,590; pounds of wax, 37,500. Every county in the State has bees, the heaviest producing counties being Spartanburg and Greenville, while the northwestern portion of the State is the heaviest producing section. It is desirable that this Station should have a good experimental apiary, but in order to organize this it is necessary to make some appropriation to put it on a working basis. For example, it should be supplied with the necessary tools and implements in our bee operations and should have about fifty complete hives with supers for the hiving of swarms and for other purposes in experimental work.

Collections.

The collections of this Division have grown considerably during the past season, but the material has not been mounted. The only time division men have for this kind of work is a short time during the winter season. The growing season is entirely taken up with field work.

Correspondence.

The correspondence of this division has grown during the past year, and the number of specimens of various kinds of farm pests sent in by correspondents, has exceeded those of any previous year. All of this material sent in is carefully filed in the records of the division with the view of getting a complete distribution of the various insects of the State from

year to year under different climatic conditions.

The work of this division has been considerably facilitated by the development of a card system begun and perfected by the stenographer of the Station, which contains a number of cross reference features by which the entomological worker is enabled to approach every activity of the division either through crop, insect, correspondent or locality. This catalog, of course, applies to every division of the Station, but in this report only that portion of it pertaining to the Division of Entomology is considered. With the development of this feature of the work this division will be assisted equally as much as it would be by the employment of an additional expert.

Publications.

Besides forty-three office forms and press articles, this division has issued two bulletins during the past season, namely, Bulletin 141, joint with Prof. Barre; and Bulletin 143, joint with Mr. Thomas. As these bulletins are bound with this annual report, no further discussion is made of them.

Work Proposed for the Coming Year.

As this division operates entirely under the Adams Fund and its work is confined to research, it has been proposed that the work this next year be a continuation of the Adams Fund problem of the past year, namely, the investigation of strongyloid parasites. While this investigation has covered a period of only one year and a half we have worked out the life history of the various pests and gotten sufficient data to open up new lines of investigation. Besides this investigation, work has been organized for a study of the relation of temperature to insect activity. The object of this investigation can best be explained by quoting the request for funds for this purpose presented to you some time ago.

Co-operative Work.

The co-operative work between this division and the Bureau of Entomology of the U. S. Department of Agriculture was continued until the first of January, when Mr. Ainslie was elected to the position of Associate Professor in the College. This caused a partial interruption of the work until June 1st, when further arrangements were made and co-operation continued on the same plan as bebfore. The principal work of the

co-operation is on cereal and forage crop insects, principally cotton root louse, southern corn root worm, cowpea pod weevil and corn stalk borer.

Very respectfully,

A. F. CONRADI,
Entomologist and Zoologist.

Clemson College, S. C., Nov. 23, 1909.

Prof. J. N. Harper, Director, S. C. Experiment Station.

Dear Sir: I respectfully submit the following report of the Chemical Division of the Station for the year ending June 30, 1909.ffl

On assuming the duties of Station chemist at the beginning of the present fiscal year, the first work was the conversion of a class room into a chemical laboratory, room 23 on the top floor of the Agricultural Hall having been set aside for this purpose. It was necessary to conduct gas lines and water pipes into this room and to build proper laboratory tables, shelves and lockers, to build a hood and to partition off a corner of the room for balance room and office. The work was accomplished and the apparatus that belonged to the Experiment Station was transferred from the chemical building and installed in our laboratory about Nov. 1, 1908.

The work done from Nov. 1, 1908 to June 30, 1909 is included in this report. The work for the year may be divided under three heads: I. Miscellaneous work; II. A continuation of the sweet potato investigation; III. A comparison of various animal sources of nitrogen with nitrate of soda as the standard, using both chemical methods and pot tests.

I. This division has been called upon by the other divisions for the following miscellaneous analyses:

By the Division of Agriculture,—1 soil analysis, 2 marl analyses, 1 rock analysis, 2 samples of acid phosphate (fertilizer analyses), 1 sample of nitrate of soda, (fertilizer analysis), 1 sample of muriate of potash (fertilizer analysis), 7 samples of wheat (protein and water). The analyses of the wheat samples would be of interest, and are included in the report.

Sample Number.	Name of wheat.	Water P. Cent.	Protein P. Cent.
1041	Bluestem	12.72	15.10
1042	J C. Stribling's Bluestem	12.26	13.69
1043	Canada	12.41	13.94
1044	Pootung Bearded	12.50	15.00
1045	Alabama	12.36	15.29
1046	Beechwood Hybrid	12.84	13.83
1047	Fultz	12.49	12.38

Division of Entomology. 1 sample of New Process lime sent to Prof. A. F. Conradi by the Field Force Pump Co., of Elmira, N. Y. The manufacturers claimed that this material was in a permanent form as calcium hydrate. The analysis is as follows:

Water (loss at 100 degrees C.)	0.09
Calcium oxide	42.33
Magnesium oxide	29.63
Carbon dioxide	9.59
Water of Combination	18.25
	99.89

Probably combined as:

Calcium carbonate	21.80
Calcium hydrate	39.80
Magnesium hydrate	27.76
Magnesium oxide	10.44
Water at 100 degrees C.	.09
	99.89

Division of Animal Husbandry. Feedstuff analyses: 4 samples of corn ensilage, 2 samples of cotton seed meal, 2 samples of wheat bran, 1 sample of mixed bran, 1 sample of corn meal. Following are the analyses of these samples:

Sample No.		Sold by	Date of Analysis.		Water.	Protein.	Fat.	Fiber.	Ash.	Nitrogen Free Extract.	Total.
1004	Mixed bran ...	Asheville Milling Co.	Asheville, N. C. ...	Nov 11, 1908	11.16	15.39	4.32	6.31	4.30	60.56	100.00
1011	Wheat bran ...	Asheville Milling Co.	Asheville, N. C. ...	Mar. 9, 1909	11.37	15.19	3.52	7.42	6.01	56.19	100.00
1013	Wheat bran ...	Asheville Milling Co.	Asheville, N. C. ...	Apr. 21, 1909	4.48	15.00	5.12	6.79	5.32	63.29	100.00
1005	Cottonseed meal	Westminster Oil & Fert. Co.	Westminster, S. C.	Nov. 11, 1908	8.13	43.35	8.57	7.12	5.84	26.99	100.00
1009	Cottonseed meal	Westminster Oil & Fert. Co.	Westminster, S. C.	Feb. 9, 1909	7.29	42.94	7.95	6.75	6.74	28.33	100.00
1006	Corn meal	A. P. Morgan Grain Co.	Atlanta, Ga.	Nov. 11, 1908	11.30	8.44	4.09	1.44	1.32	73.41	100.00
1007	Corn silage ...	From Silo No. 1.	Station barn.	Nov. 11, 1908	73.93	1.77	0.86	6.76	1.12	15.56	100.00
1008	Corn silage ...	From Silo No. 2.	Station barn.	Feb. 9, 1909	78.57	1.63	0.60	5.39	0.61	13.20	100.00
1012	Corn silage ...	From Silo No. 3.	Station barn.	Mar. 9, 1909	79.04	1.34	1.16	5.99	1.77	10.70	100.00
1014	Corn silage ...	From Silo No. 4.	Station barn.	Apr. 2, 1909	75.63	1.34	1.09	6.39	1.19	14.36	100.00

II. The work on the sweet potato investigation was published in Bulletin 146 of the Experiment Station, and it is made a part of this report. A synopsis of this work is a follows:

Objects of the Work.

1. The test of these varieties was inaugurated in order that, in case the manufacture of starch from sweet potatoes should assume any proportions, we would have the necessary knowledge of the starch content and of the comparative yields of the different varieties to enable us to begin systematic work, using the most promising varieties to breed for high starch content; and also to be able to recommend the varieties which now show the highest starch content.

2. In order to show the content of fermentable carbohydrates and to show their possible utilization as a source of alcohol.

3. To put before the public information regarding their value as a feeding stuff, a side of the work which has not been much stressed in our previous work here.

4. To obtain results as to the fertilizing elements removed from the soil by a crop of sweet potatoes.

5. To show the content of water, starch, sugars, and protein at different stages of growth.

Description of the Varities.

Nancy Hall: Potatoes large, oblong, yellow; with flesh mottled yellow and white. They are a good shape, rather prolific, and very early maturers, but were found to be rotting badly in the field about October 1st, from a white, soft rot. These potatoes also had large longitudinal splits, which, perhaps, might be accounted for by the excessive rains. They made a most luxuriant growth of vines.

2. Polo: Medium to large in size, very smooth, rather round, white potato; flesh white. Makes a very luxuriant growth of vines. Somewhat attacked by disease in the field.

3. Southern Queen: Medium sized, very smooth white skin, white flesh; but has some longitudinal splits in the surface, which may have been caused by the heavy rains. The potatoes are rather irregular in size, but free from disease. A very heavy yielder, also makes a heavy growth of vines.

4. White Spanish: Very irregularly shaped, a few being

large, smooth and roundish; but the majority being long and stringy. They have a perfectly white flesh and white skin. They are not prolific, but make a heavy growth of vines.

5. Gen. Grant: The potatoes from this variety may be divided into two classes: the large ones, which are smooth potatoes of good size; and the small ones, which are stringy. The skin is the lightest shade of yellow, while the flesh is pure white. It is not a prolific yielder, but vines make good growth.

6. Brazilian: Large, uniform, roundish, smooth, light yellow potato, with white flesh. A very prolific bearer, and seems entirely free from disease. Makes a very heavy growth of vines.

7. Arkansas Beauty: Long, tapering, smooth, yellowish potato, uniform in size, borne in clusters. Skin yellow, flesh light yellow, and very delicate looking. Somewhat attacked by disease in the field. A poor yielder, but makes a good growth of vines.

8. Tennessee Notchleaf: Rather small, somewhat stringy potatoes, which are borne in large clusters. It is a yellow fleshed variety. Was attacked by a white rot before gathering. Very prolific, but makes very little growth of vines.

9. Yellow Nancemond: Smooth, long, tapering, uniform, yellow potato; but very small in size, the flesh being almost white. Bears in clusters, and is quite prolific. The vines are small and have not much foliage. Showed some signs of rot about October 1st.

10. Purple Yam: Very long in proportion to diameter; the skin is purple, while the meat is pure white. Not at all prolific. The tubers are very scattering, and push up the soil like a mole. Vines: large stems, and few leaves. Some insect work was noticeable during the growing season.

11. Pumpkin Early Yellow Yam: Medium sized, smooth, well formed, light yellow potato. Flesh mottled yellow and exceptionally deep in the ground, and form white. Potatoes seem very much subjected to disease. They make a heavy growth of vines.

12. Shanghor Yam: A somewhat irregularly shaped, white fleshed variety, skin slightly yellow. Much larger percentage of large to small tubers than that of White Spanish. Seems

entirely free from disease. The large potatoes have longitudinal splits. These are perhaps caused by the excessive rains of August and September, followed by a prolonged drought. This potato is not what is usually called a yam; for it analyzed high in starch and low in sugar. It is not prolific.

13. Vineland Bunch Yam: Long, tapering, uniform; but rather small tubers; having a yellow skin, and white and light yellow mottled with white flesh, with some deeper yellow spots. Not much vine growth, and a shy bearer.

14. Fulleton Yellow Yam: Potatoes very long in proportion to diameter, bears in large clusters, and is very prolific, being decidedly the most prolific of the sugary varieties which we grew. They have a light yellow skin, while flesh is white spotted with yellow. Somewhat attacked by insects in the field.

Results of Work on Starch Content.

It might be well to state here how the samples were prepared. A representative measured section of a row was dug and weighed, and as representative a sample as we could take was selected. These samples were taken to the laboratory, where they were immediately washed—each potato being rubbed with a brush which loosened up the sand, but did not bruise the skin. They were placed on wire racks, and allowed to dry at room temperature for 36 hours. In this time, they were free of moisture on the outside, but were not shrivelled. The conditions were the same for all varieties. In this way, the analyses fairly well represented the potatoes at the time of digging. A representative subsample was then taken, weighed, sliced thinly, and dried at a temperature of about 55 degrees C. After drying the chips until they became quite brittle, they were taken out of the oven cooled and weighed. The sample was then ground, and the moisture determined by heating at 100 degrees C. to a constant weight. It requires eight to ten hours' continuous heating to get this constant weight. The starch is then determined in a fresh portion of the sample by the diastase method.

The following table is intended to show the rate of yield per acre, per cent. water, per cent. starch, and pounds of starch per acre:

TABLE I. *Showing rate of yield per acre, water content, starch content, and calculated yield in pounds of starch per acre.*

VARIETY.	Rate of Yield per-Acre in Bushels.	Per cent. Water.	Per cent. Starch.	Pounds of Starch per Acre.
Nancy Hall	270.0	68.75	17.82	2694
Polo	281.0	72.53	14.85	2337
Southern Queen	416.0	68.38	19.07	4443
White Spanish	141.0	67.27	20.05	1583
General Grant	191.0	66.52	17.30	1850
Brazilian	450.0	65.45	16.46	4148
Arkansas Beauty	158.0	72.80	14.43	1277
Tennessee Notchleaf	281.0	68.87	16.71	2629
Yellow Nancemond	214.0	72.12	13.50	1618
Purple Yam	180.0	65.57	19.40	1956
Pumpkin Early Yellow Yam	270.0	62.20	20.63	3048
Shanghor Yam	174.0	65.82	23.89	2328
Vineland Bunch Yam	141.0	69.84	19.22	1483
Fulleton Yellow Yam	326.0	67.74	18.72	3418

While the bushels-per-acre yield in the preceding table, on account of being calculated from small areas, can be taken only as comparative, yet the column headed per cent. starch shows that there is considerable variation in the starch content of the different varieties. One indication which appears worthy of note from the foregoing table, is that the water content, as a rule, varies from 65.0 to 69.0 per cent., and it seems that any considerable increase of this per cent. is accompanied by a corresponding decrease in the starch content—the percentage of the starch being about as many per cent. below the average as the water per cent. is above the average. There are three striking examples of this,—the Polo, the Arkansas Beauty, and the Yellow Nancemond, all of these varieties containing over 72 per cent. water and below 15 per cent. starch.

Of the varieties in this test, the Southern Queen, Brazilian, Fulleton Yam, Pumpkin Yam, Nancy Hall, and Tennessee Notchleaf appear to rank in the order named; but the Pumpkin Yam and Nancy Hall, on account of the color of their meat, which is yellow, would probably discolor the starch. Both the Southern Queen and the Brazilian are white, which is quite an

advantage in starch manufacture. They are also the two heaviest yielders. Another variety, the Shanghor Yam, although not prolific, is worthy of special notice on account of the high starch content, and low content of other constituents.

Fermentable Carbohydrates.

Wheat, oats, rye, barley, maize, rice, and other grains, as well as fruits, sugar-cane, beets, potatoes, and carrots may be made to yield alcohol by fermentation. This is brought about by allowing the reproduction of a peculiar, low vegetable growth, which feeds on the sugar and converts it into alcohol and carbondioxide, together with small quantities of other compounds. Although alcohol can be produced synthetically by a variety of laboratory processes, the fermentation of saccharine matter is the method always resorted to on a large scale. Recently, the use of industrial alcohol has received quite an impetus in this country, on account of the more liberal laws relative to it, which have gone into effect. The sweet potato might serve as a valuable source of fermentable carbohydrates for the production of alcohol. For, in addition to its content of starch, which would first have to be converted into sugars and then fermented, it also contains several per cent. of sugars. The sugar content varies with the time of gathering, which will be discussed in a later section, and with the length of time of storage [7]. McDonnell, [8] in his work on starch manufacturing, has called attention to the fact that the first wash waters and the pulp might be fermented and the alcohol derived in this way recovered, thus furnishing a valuable by-product to the starch industry. In this work, we will consider the glucose, sucrose, and starch as the only fermentable carbohydrates. If there are others present, they are in very small quantities. Table II gives the yield per acre, the per cent. glucose, sucrose, starch, total fermentable carbohydrates and yield calculated from these carbohydrates in gallons per acre of alcohol. This, however, would not represent the true yield; because, during the process, some other products are formed,—these by-products

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7 Bulletin 63 S. C. Experiment Station.

8 Bulletin 136 S. C. Experiment Station.

are fusel oil, and several isomeric and homologous alcohols and their esters. The quantity of by-products represents approximately from four to six per cent. of the fermentable[9] materials. There would also be some loss in the process. However, the entire loss rarely ever goes above 15 per cent.

TABLE II. *Showing calculated yield per acre, per cent. glucose, sucrose, starch, total fermentable carbohydrates and yield calculated from the carbohydrates of gallons of alcohol per acre.*

VARIETY.	Rate of Yield per Acre in Bushels.	Per cent. Glucose.	Per cent. Sucrose.	Per-cent. Starch.	Per cent. Fermentable Carbohydrates.	Theoretical Yield in Gallons of Alcohol per Acre.
Nancy Hall	270.0	1.53	2.35	17.82	21.70	292.1
Polo	281.0	1.75	2.02	14.85	18.62	260.6
Southern Queen	416.0	1.51	2.18	19.07	22.76	473.5
White Spanish	141.0	0.55	3.36	20.05	23.96	169.5
General Grant	191.0	0.31	4.09	17.30	21.70	207.5
Brazilian	450.0	1.22	2.89	16.46	20.57	462.2
Arkansas Beauty	158.0	1.78	3.25	14.43	18.64	152.7
Tennessee · Notchleaf ..	281.0	2.00	2.38	16.71	21.09	295.1
Yellow Nancemond	214.0	1.36	3.78	13.50	18.64	198.1
Purple Yam	180.0	1.44	2.18	19.40	23.02	207.4
Pumpkin Early Yellow Yam	270.0	1.69	3.66	20.63	25.98	343.6
Shanghor Yam	174.0	0.49	2.77	23.89	27.15	181.1
Vineland Bunch Yam ..	141.0	1.83	3.23	19.22	24.28	167.6
Fulleton Yellow Yam ..	326.0	0.52	3.36	18.72	22.60	369.3

FEEDING STUFF VALUE OF THE SWEET POTATO.

In view of the great need which confronts us in the South of a cheaper and more productive carbohydrate than corn, we have made feeding stuff analyses of the fourteen varieties of sweet potatoes grown during 1908. While there would be a great deal of trouble in keeping sweet potatoes the whole year round, and their value at certain seasons, if they are successfully kept, is so great as to be prohibitive of using them as a stock feed, yet they could be fed judiciously to great advantage

9 Industrial Alcohol—Its Manufacture and Uses, p. 41, Herrick.

from the first of September to the first of January. And even when there is a good market, the scarred ones and culls could be fed to good advantage. All kinds of stock seem very fond of them, and they possess a great advantage over the other root crops, in that they contain as high as 37 per cent. of dry matter, and can be depended upon to contain as high as about 30 per cent. of dry matter. Besides, sweet potatoes are better suited to our conditions than are most of the other root crops. Below is given a table showing the average feeding stuff analyses of several of our similar crops, and also that of corn. All of these analyses are taken from Henry's Feeds and Feeding, except that of sweet potatoes, which is the average of our work for this year.

TABLE III.. *Shows anaylses of various feeding stuffs.*

CROP.	Per cent. Water.	Per cent. Ash.	Per cent. Protein.	Per cent. Crude Fiber.	Per cent. Nitrogen Free Extract.	Per cent. Ether Extract
Irish potato	78.9	1.0	2.1	0.6	17.3	0.1
Beets, common	88.5	1.0	1.5	0.9	8.0	0.1
Beets, sugar	86.5	0.9	1.8	0.9	9.8	0.1
Beets, mangels	90.9	1.1	1.4	0.9	5.5	0.2
Turnips	90.5	0.8	1.1	1.2	6.2	0.2
Ruta-bagas	88.6	1.2	1.2	1.3	7.5	0.2
Carrots	88.6	1.0	1.1	1.3	7.6	0.4
Parsnips	88.3	0.7	1.6	1.0	10.2	0.2
Artichokes	79.5	1.0	2.6	0.8	15.9	0.2
Sweet potato	68.1	1.0	1.6	0.9	27.9	0.5
Corn	10.6	1.5	10.3	2.2	70.4	5.0

On land in this State, which, under the ordinary system of cropping, yields 20 bushels of corn, we should be able to produce about 200 bushels of sweet potatoes. The potatoes would furnish more than three times as much nitrogen free extract and as much, or more, of each of the other proximate constituents of a feeding stuff as that contained in the corn. From the preceding table, we will note that the Irish potato contains 2.1 per cent. of protein, which is more than the amount contained in the sweet potato; but about one-half of the calculated protein of the Irish potato is really nitrogen present in the form of amides, which do not have the feeding value that the albumi-

noids have. In order to determine whether or not any of the nitrogen present in the sweet potato was present in the form of amides, we made determinations on all of the varieties and found that there were no amides present.

It is probable that one of the reasons that we sometimes get poor results from the feeding of cotton seed meal, lies in the fact that we often feed too narrow a ration; that is, that we often have relatively too much digestible protein present in proportion to the digestible carbohydrates. If cotton seed meal and sweet potatoes were mixed at the rate of one pound of cotton seed meal to eight pounds of potatoes, we would get a nutritive ratio of close to one to six, which is the best ratio for milk cows. The potatoes make a good food for hogs.

TABLE IV. *Shows the yield and feeding stuff analyses of the different varieties.*

VARIETY.	Yield. Bushels.	Per cent. Water.	Per cent. Protein.	Per cent. Fat.	Per cent. Fiber.	Per cent. Ash.	Nitrogen Free Extract.
Nancy Hall	270.0	68.75	1.75	0.60	1.00	0.89	27.01
Polo	281.0	72.53	1.52	0.33	0.78	1.09	23.75
Southern Queen .	416.0	68.38	1.52	0.47	0.74	1.08	27.81
White Spanish ..	141.0	67.27	1.48	0.45	0.73	0.89	29.18
General Grant ...	191.0	66.52	1.34	0.74	0.82	0.79	29.79
Brazilian	450.0	65.45	1.65	0.56	1.00	1.10	30.24
Arkansas Beauty .	158.0	72.80	1.66	0.49	0.96	1.09	23.00
Tennessee Notch-leaf	281.0	68.87	1.50	0.51	1.05	1.04	27.03
Yellow Nancemond	214.0	72.12	1.33	0.50	1.09	1.00	23.96
Purple Yam	180.0	65.67	1.83	0.33	1.01	1.19	29.97
Pumpkin Early Yellow Yam ..	270.0	62.20	2.18	0.65	0.97	1.11	32.89
Shanghor Yam ..	174.0	65.82	1.15	0.31	0.66	0.82	31.24
Vineland Bunch Yam	141.0	69.84	1.45	0.50	0.73	0.70	26.78
Fulleton Yellow Yam	326.0	69.74	1.77	0.37	0.79	0.83	28.50
Average	250.0	68.1	1.6	0.5	0.9	1.0	27.9

Of these varieties, the Brazilian and the Southern Queen seem most admirably adapted to the purpose, while the Fulleton Yam and the Pumpkin Early Yellow Yam seem to be close seconds. Probably, it would be well to plant the Nancy Hall,

which matures very early, and the Brazilian or Southern Queen in order to have a succession. We are unable to say now whether it would be most profitable to pulp them or chop them and feed them raw or to cook them.

In addition to the value of the tubers as a feed, the vines also are highly nutritious and much relished by stock. Shiver [10] says that the green vines from 200 bushels of potatoes will weigh, approximately, 9,500 lbs.; but, of course, this varies a great deal with the variety. The Brazilian and Southern Queen both make a very luxuriant growth of vines, while the Fulleton Yam and Pumpkin Early Yam make average growth of vines. The four varieties which showed the most luxuriant growth of vines were Brazilian, Polo, Southern Queen and Nancy Hall; and it is worthy of not that these four varieties were among the heaviest yielders of roots.

On September 29th, we gathered some of the vines from each of these four varieties; these vines were taken from so small a space of ground that no attempt was made to calculate any yield per acre. They were cured, thoroughly dried and analyzied, being calculated to the waterfree basis.

MOISTURE FREE MATERIAL.	Protein.	Fat.	Fiber.	Ash.	Nitrogen Free Extract.	Total.
Brazilian	12.30	5.15	17.10	9.78	55.67	100.00
Polo	14.28	4.88	17.98	9.06	53.80	100.00
Southern Queen	11.28	4.34	18.70	8.04	57.64	100.00
Nancy Hall	12.07	5.05	19.11	8.03	55.74	100.00
Average	12.48	4.86	18.22	8.73	55.71	100.00

The great trouble would be, however, the expense of gathering these vines, which are not only trailing vines but they take root in many places. On account of the high percentage of fertilizing constituents present, and the great need for humus in our soils, perhaps, taking into consideration the cost and difficulties of gathering, it would be best to leave them on the land. If, however, they can be gathered cheaply and are fed on the farm and the manure saved and returned to the land.

the feeding would unquestionably be best. Let us compare the percentage composition of these vines with the composition of some other similar feeds also calculated to the waterfree material:

WATERFREE.	Protein.	Fat.	Fiber.	Ash.	Nitrogen Free Extract.
Red clover hay	14.52	3.90	29.28	7.32	44.98
Crimson clover hay ...	16.81	3.08	30.09	9.51	40.51
Cowpea hay	13.59	2.46	22.51	8.40	48.14
Soja bean hay	17.36	5.86	25.14	8.12	43.52
Average	16.82	3.83	26.76	8.34	44.25
Sweet potato vines	12.48	4.86	18.22	8.73	55.71

In using the expression, "similar crops," I mean with reference to physical similarity, all of these hays being from vines, except the clovers, which are also of dense foliage; however, they all differ from the sweet potato, in that they are legumes. These hays, with which we have made this comparison, are among the highest in content of nutrients; and, while they contain about four per cent. more protein on an average than the sweet potato vines, yet they also contain over eight per cent. more fiber, which is the least valuable of the proximate constituents of a feeding stuff. The sweet potato vines have the decided advantage in the content of fat and of nitrogen free extract. While we do not mean to contend that the sweet potato vine is as nutritious as the hays named, we do know that stock are very fond of these vines, and that they contain high percentages of the proximate constituents—constituents which give the feeding stuffs their value.

TABLE VII. *Fertilizing Elements Removed by a Crop of Sweet Potatoes.*

VARIETY.	Bushels per Acre.	Per cent. Total P_2O_5	Per cent. Nitrogen.	Equivalent to Ammonia.	Per cent. Potash.	Value Removed per Acre.
Polo	281.0	0.0768	0.243	0.295	0.479	$11.83
Nancy Hall	270.0	0.0573	0.280	0.332	0.445	11.75
Southern Queen	416.0	0.0775	0.243	0.295	0.492	16.72
White Spanish	141.0	0.0798	0.236	0.287	0.434	5.67
General Grant	191.0	0.0773	0.214	0.260	0.388	8.12
Brazilian	450.0	0.0553	0.271	0.329	0.534	20.69
Arkansas Beauty	158.0	0.0869	0.266	0.323	0.519	7.26
Tennessee Notchleaf	281.0	0.0435	0.245	0.298	0.343	10.55
Yellow Nancemond.	214.0	0.0519	0.213	0.259	0.390	7.62
Purple Yam	180.0	0.0525	0.292	0.355	0.506	8.54
Pumpkin Early Yellow Yam	270.0	0.0840	0.348	0.423	0.684	16.04
Shanghor Yam	174.0	0.0621	0.184	0.229	0.336	5.51
Vineland Bunch Yam	141.0	0.0893	0.231	0.281	0.392	5.45
Fulleton Yellow Yam	326.0	0.1069	0.283	0.344	0.382	14.82
Average	250					$10.73

Cost of fertilizer removed per bushel $0.043

The foregoing table shows the value of the fertilizing materials removed by crops of sweet potatoes, taking the following values per pound: Phosphoric acid (P_2O_5), $0.05, potash ($K_2O$) $0.05 and ammonia ($NH_3$) $0.16. On an average $0.043 worth of phosphoric, notrogen and potash were removed by each bushel of potatoes, most of the sweet potatoes being made up of carbohydrates and water, both of which are derived from the atmosphere. At this rate, a crop of 200 bushels would remove $8.60 worth of nitrogen, phosphoric acid and potash. In addition to the amounts of fertilizing ingredients removed by the roots, the vines made a heavy draft on the soil; however, if they are left on the land or are fed and the manure is returned to the land, it becomes richer on account of the organic matter gained. We often hear the expression, "That is an old potato patch," referring to an exceptionally fertile plot. This may be accounted for by the fact that heavy applications of fertilizer are often made to potatoes, or because the plant feeds

to some depth, or it may have the power of decomposing, by the excretions from its roots, some compounds not usually available to plants,—in any case the vines put much organic matter into the soil; and, when they decay the food is on the surface and is readily available. The mechanical condition of the soil would be improved by the shading of the vines, because the ground would be kept moist and warm, which condition would be good for bacterial growth and also for the breaking down of the soil particles.

Below is given a table showing the percentage composition in fertilizing ingredients of the moisture-free vines:

WATERFREE MATERIAL.	Nitrogen.	Ammonia.	Phos. Acid.	Potash.	Value per Ton.
Nancy Hall	1.94	2.35	0.363	2.55	$10.45
Polo	2.29	2.78	0.254	3.53	12.68
Brazilian	1.97	2.39	0.274	3.00	10.92
Southern Queen	1.81	2.20	0.260	2.16	9.46

We are unable to state how much the moisture-free vines per acre would weigh; this varies greatly with the variety, because some varieties make a very much heavier growth of vines than others. Shiver** estimates that there would be 9,500 lbs. of green vines with a crop of 200 bushels of potatoes. We would expect as much of this as 10 per cent. to be water-free material, which would make 950 lbs. This, however, would vary with the variety.

Determination of the Content of Water, Protein, Starch, and Sugars at Different Stages of Growth.

From the results of this work, which was done on four varieties, two of the sugary varieties and two of the starchy varieties,—Fulleton Yam, Purple Yam, Nancy Hall and Polo, we are led to believe that the starch content is at its maximum from about October 1st to 20th. that the yield also is near its maximum at this time, and the water content is about at its minimum. It necessarily follows that the dry matter is at is maxi-

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**S. C. Expt. Sta. Bulletin 28.

mum, but we found the protein to be at nearly its minimum. On August 28th the glucose was at its minimum and the sucrose was at its maximum, the glucose gradually increasing and the sucrose gradually decreasing until September 29th, when we find the per cent. of glucose is greater than the per cent. of sucrose; but that the per cent. of total sugar is at its minimum. On November 18th, when the crop was dug, the per cent. of sucrose was again higher than the per cent. of glucose; and the total sugars had increased over September 29th. The vines having been killed for some time, we see that the increased sucrose must have been caused by the changing of some of the starch, which bears out Shiver's work on storage. However, the work is not at present complete enough to publish in full. We hope at some future date to get out a paper on it.

III. The third section of the work, the comparison of the various animal sources of nitrogen with nitrate of soda, was confined to the following animal products: (1) Dried blood, (2) ground fish, (3) kid fleshings, (4) hoof meal, (5) tankage (leather), (6) bone meal, (7) tankage, (ordinary), (8) Munro's dark azotin, (9) Munro's light azotin. Fertilizer analyses were made of all of these materials and the per cent. of available nitrogen determined in each by the pepsin hydrochloric acid method and by the neutral permanganate method. We found that there was no close agreement between the available nitrogen found in the different samples by these two methods. The work is being continued with pot experiments. This pot work is carried out as follows: Earthen flower jars are used, We got from the Experiment Station farm a sample of several hundred pounds of chocolate clay soil which represents a great deal of the land of the Piedmont region, and into each of the pots eight pounds of soil was weighed and amounts of the material carrying nitrogen equivalent to one-half a gram of ammonia was added to each pot, phosphoric acid and potash being added so that each pot contained the same amount of phosphoric acid and potash, the amount of these materials carried in the fertilizer being taken into consideration. These pots were worked in duplicate and one series of them has reached

maturity. This was planted in corn. While we are not drawing conclusions from the work of one series, yet we have found some marked differences in the growth of the plants in the different pots. We will try two more series of pots using small grain for our plants, wheat and oats, and on the basis of the three pot experiments we intended to report our results. We will reserve our report on the work done on these materials until it is completed.

Very respectfully,
T. E. KEITT,
Chemist.

July 6, 1909.

Prof. J. N. Harper, Director, S. C. Experiment Station.

Dear Sir: During the past year the Division of Animal Husbandry and Veterinary Science has continued the experiment which was already in progress to determine the physiological effects of feeding cotton seed meal in large quantities to dairy cattle. As all of the cows had been fed more or less cotton seed meal it was not thought advisable to take any cows off it entirely but varying amounts were fed, from three to eight pounds, daily per head, and careful note taken of any morbid conditions which might have resulted from such feeding.

During the year a number of abortions took place besides a number of cases in which difficulty was experienced in getting animals pregnant, and it appeared there was a fairly constant relation between these troubles and the amount of cotton seed meal fed, depending also upon the weight of the animal and the amount fed about the period of conception. In some instances there has been noticed a peculiar form of mammitis, notably in the case of a Jersey cow in which attacks had occurred during a previous two years at intervals of from two weeks to two months and had become so bad as to threaten to destroy the usefulness of this cow. During most of this period 6 lbs. daily of cotton seed meal had been fed. In September, 1908, this amount was decreased to 4 lbs., and shortly afterwards to 3 1-2 lbs. and from that date up to the present only two attacks have

been noticed, only one of which was at all severe. Another cow, a Devon, developed apparently the same trouble in November and has had attacks since occurring once or twice each month. From July, 1908, this cow has been fed 6 to 7 lbs. of cotton seed meal daily, which was considerably more than she ever received through any other like period.

The general health of the herd has not been seriously interferred with by the feeding of cotton seed meal, though individual cases have shown a steady loss of weight and milk supply while being fed large amounts and on being changed to a mixed feed have promptly responded both by increase in weight and milk flow. The results of this work will shortly be published and while it is not absolutely certain that the cotton seed meal is solely responsible for the abortions occurring, it seems to at least bear some relation to the trouble, and in view of the above facts it is recommended that not more than 3 1-2 to 4 lbs daily be fed to mature cows in full milk, correspondingly less for younger cows, and none at all to heifers before freshening for the first time.

By this it is not intended to discourage the rational use of cotton seed meal as a dairy feed as if fed in these amounts bad results will seldom follow, and it is recognized as the cheapest protein feed obtainable. It is expected that this work will be continued in such a way that the relation between the feeding of cotton seed meal and abortions in cows may be more exactly determined.

An experiment was also conducted to determine if cotton seed meal could be fed profitably to hogs in small amounts and to study the pathological changes in organs from hogs killed with cotton seed meal. Twelve hogs were divided into pens, four in each pen, the total weight at the beginning being for pen No. 1, 346 lbs; pen No. 2, 417 lbs.; pen No. 3, 473 lbs. Pen No. 1 was fed a ration consisting of 2 parts by weight of cotton seed meal and 1 part wheat middlings. Pen No. 2 was fed a mixture of 1 part cotton seed meal to 2 of wheat middlings; while No. 3 was fed 1 part of cotton seed meal to 4 of wheat middlings. By the end of the tenth week three pigs had died in pen No. 1, the remaining one being sick, definite symptoms having been noticed in the eighth week. One also had died

from pen No. 2, while two others were very sick. Those in pen No. 3 had shown no ill results. At this time the remaining hog in pen No. 1 and the three in pen No. 2 were taken off the cotton seed meal entirely and put on straight wheat middlings when improvement continued steadily, no further deaths taking place. Pen No. 3 continued on the same feed until the end of the twelfth week when one died, having been sick for a few days, and by this time another had sickened. These remaining three were then placed on wheat middlings, improvement being noticed almost immediately and no further trouble resulting. All were slaughtered shortly afterwards in good condition. Calculating from the total amount fed to each pen and taking the average of the weights of the hogs at the beginning and end of the experiment, it was found that pen No. 1 was fed 107.8 lbs. of cotton seed meal per 100 lbs. live weight during a period of ten weeks; that No. 2 was fed 67.2 lbs. per 100 lbs. live weight during the same period; and that pen No. 3 was fed but 43.6 lbs. per 100 lbs. live weight over a period of twelve weeks. Symptoms and lesions on post-mortem examination were fairly uniform, showing in all cases pneumonia and congestion or hemorrhagic condition of the mesenteric glands, the digestive tract itself showing but very slight alterations in two cases only. Histological examinations of all the important organs revealed little except in the lungs where considerable cellular exudate was found to occupy the air cells.

The results indicate that cotton seed meal cannot be safely fed to hogs even in small amounts for an extended period and also point to the fact that that there is contained in cotton seed meal a specific oxine which affects first the lymphatic glands draining the digestive tract, and secondly the lungs.

The results obtained by different investigations on this problem have not been at all uniform and this may probably be explained to a great extent on the assumption that the amount of the toxic principle in cotton seed meal may very in different samples, due, possibly to variety of soil and conditions of growth.

It is well recognized that samples of cotton seed meal vary in the proportion of their known constituents, and it is reasonable to suppose that this may be true as affecting the toxin principle

and this idea is being kept in view in the work being now done in co-operation with the Division of Chemistry.

Some work has also been done in co-operation with the Bureau of Animal Industry, Department of Agriculture, to determine the value of the method of immunizing against hog cholera as advocated by the Bureau of Animal Industry. For this purpose a hyperimmunized hog was kindly provided by the Department of Agriculture and was bled four times at intervals of a week apart. The serum thus obtained was mixed together and to test its potency four hogs were obtained weighing around 100 lbs. each and were given 2 cc.'s of virulent blood which was also provided by the Bureau of Animal Industry, No. 1 received no protective serum; No. 2 got 5 cc.'s; while No. 3 and No. 4 got 10 and 20 cc.'s respectively, this being given at the same time as the injection of virulent blood. On the seventh day following the injections No. 1 was noticed sick and died early on the eighth day, death taking place so suddenly that no time was allowed for the typical lesions of hog cholera to develop. Shortly after this No. 2 sickened but evidently got some protection from the small amount of 5 cc.'s of serum as he lived for three weeks from the time of the inoculation, and on post-mortem examination typical lesions of hog cholera were found. Nos. 3 and 4, receiving 10 and 20 cc.'s respectively of the serum, suffered no inconvenience beyond a rise in temperature shortly after the inoculation and have since received doses of 10 cc's each of virulent blood without any marked effect. While we have had no opportunity as yet to use this method in a practical way in outbreaks of hog cholera through the State we believe it to be the surest method known of preventing hog cholera and lessening the loss when applied early in an outbreak and we are keeping a quantity of serum on hand to be available as required.

In co-operation with the Division of Zoology work has been continued on the investigation of the stomach worm and hook worm disease of young calves. An effort was made to determine the relative degree of infestation on high land pastures and on low bottom land and twenty-one calves were divided into two lots, nine being placed on the bottom land, while twelve were placed on high pasture, both of these lots being infested

the previous season. At the end of the season six calves had died in the lower lot of nine, while four deaths had occurred in the upper lot of twelve. The infestation as evidenced by post-mortem examination ranged from very slight to moderately severe and except in one instance, that of a calf on the high pasture which showed lesions of calf pneumonia, no evidence of any other disease was present. This would leave three possible deaths from stomach worm disease on the high pasture giving the percentage of deaths in that lot as 27 per cent. against 66 per cent. in the low bottom pasture which may be taken as conclusive evidence that low, moist lands are much more favorable for the development of this disease than high lands. It should be stated that the calves used in this experiment were approximately of the same age in the two lots and were treated exactly the same, except that those in the low pasture received their water from a creek flowing through; while in the highland pasture, water had to be carried to them.

An attempt was also made to determine the possibility of artificially infesting calves with the stomach worm and for this purpose a calf five months old was taken and fed ensheathed larvae hatched in the zoologist's laboratory. This feeding was continued almost daily from November 27th to December 23rd, many hundreds of the parasites being taken in each day with the feed. On January 21st post-mortem examination was made on the animal and after careful search not more than twenty stomach worms were found. It would seem from this that animals over five months old do not very readily become infested with the ensheathed form of the larvae, though this has been generally admitted to be the usual manner of infestation. However, such experiments need to be repeated to give conclusive results.

Work is also underway with a portion of the dairy herd with the view of demonstrating the possibility of reducing the cost of feeding by depending more upon home grown crops than upon the expensive commercial concentrates, and to this end the growing of the crops necessary for the feeding of these animals has been taken over by this Division. While this will increase the work of this Division, it will at the same time place us in a position to give more reliable data as to the cost of pro-

ducing such feeds, and together with the keeping of accurate records as to the amounts fed each animal, the amount of milk production, etc. will enable us to advise the dairy farmer as to the most profitable crops to grow for this purpose.

The breeding of Berkshire hogs has been continued and we have been able to distribute a number of well bred and high class individuals to farmers at moderate prices which cannot fail to stimulate the growth of this important industry.

The correspondence has not been very heavy, but it is gratifying to notice that many farmers are taking a more lively interest in matters pertaining to animal husbandry and especially the dairy industry, than they have before shown.

Respectfully yours,

E. BARNETT,

Veterinarian and Animal Husbandman.

Clemson College, S. C., July 1st, 1909.

Prof. J. N. Harper, Director, S. C. Experiment Station.

Dear Sir: In compliance with your instructions, I beg to submit the following report of a part of the work of the office division of the Secretary and Librarian of the South Carolina Experiment Station, covering the period of the fiscal year, beginning July 1st, 1908 and ending June 30th, 1909.

The accounts of receipts and expenditures of the department have been accurately kept and carefully classified under the regulations designated by the Office of Experiment Stations, Washington, D. C. As required by law, a complete separation in keeping the accounts of the expenditures of the Hatch and Adams Funds, has been specially observed.

A complete file of all bulletins emanating from all the Experiment Stations in the United States and many foreign countries, is regularly received. These publications are specially preserved, their numbers and subjects placed on record in the bulletin catalog, and they are subsequently arranged into appropriate form and bound into volumes for permanent reference. About sixty volumes of these bulletins, representing the work of the various stations in the United States, have recently been prepared for the binder, and this work will be pushed to completion as soon as the necessary funds are available

for use.

The paramount importance of putting into permanent form a record of the results of investigations at the various Experiment Stations may be emphasized in a few brief statements. There is scarcely a science that has not been called into exercise by some one of the Experiment Stations. Many are now engaged in the examination of problems relating to meteorologic and climatic conditions. Some time ago twenty-seven were engaged in studying the soil, its geology, physics, or chemistry, and making tests in tillage, drainage and irrigation. Thirty-five were making analyses of commercial and domestic fertilizers. Thirty-nine were studying the more important crops with reference to cultivation, application of fertilizers and solving questions in the problem of rotations. Twenty-five were directing their inquiries into the composition of feeding stuffs and making digestion experiments. Twenty-four were interested in the production of milk, beef, mutton and pork. Eighteen were giving their attention to the solution of questions related to dairying, such as the bacteria of milk, butter-making and the construction and management of creameries. Botanical studies were engaging the attention of thirty-three; questions in Horticulture, thirty-five; and Veterinary Science, eighteen. Some have begun operations in Forestry, and a few experiments are being conducted in Apiculture and Aviculture. Thus it will be seen that the work is as varied as it is comprehensive, and the importance of its preservation in permanent form for future use cannot be over estimated. Few have more problems of such absorbing interest, or that offer greater remuneration for their solution than these.

Considering its limited resources and equipment, this office is accomplishing a large amount of useful work, and continues to give wider and wider publicity to the results attained. It is the purpose of the secretary that the dissemination of information regarding the progress of agricultural research shall sweep the horizon of the State in the very near future. The number of new accessions to our permanent mailing list, since the last report amounts to twelve hundred.

Twenty-five press bulletins of four pages containing the

analyses of commercial fertilizers have been sent out from this office. These have been mailed in weekly editions of 12,000 copies each, only to the farmers of the State, from the beginning of the season to the close of the fiscal year, aggregating 300,000 copies.

There have been distributed from this office seven other bulletins in editions of 14,500 copies each, making a total of 101,500. Added to the above, it will be seen that there is a grand total of 401,500 publications that have been sent out from this Office during the fiscal year just closed. The seven bulletins referred to in the preceding lines represent intelligent and profitable discussions of quite a variety of interesting agricultural subjects such as "Treatment of Plant Diseases and Injurious Insects in South Carolina," "Stomach Worm Disease of Sheep and Young Cattle," "Some Injurious Orchard Insects," "Celery," "Fertilizer Experiments with Cotton," "Sweet Potato Work in 1908," and "Analyses of Commercial Fertilizers." These all contain many useful suggestions and embrace in the main the fundamentals of agricultural attainment such as the improvement in varieties, increase of yield and finer qualities in every product.

Below will be found a list of the publications of the South Carolina Experiment Station.

(Numbers marked thus * are exhausted.)

Bulletins of the Station are sent free to all citizens of the State requesting them.

NEW SERIES.

Report of Experiment Farm.

No. 1. *Tests of varieties of cotton.

No. 2. *Tests of commercial seeds.

No. 3. *Analysis of fertilizers and feeding-stuffs.
*Annual report.

No. 4. *Entomology.

No. 5. *Oats and wheat.

No. 6. Hog cholera.

No. 7. Meteorology.

No. 8. *Chemical statistics of corn in South Carolina.
Maize fodder ensilage; cow peas as a forage crop.

Composition of soja bean vines.
Annual report.

NEW SERIES.

No. 1. *Analyses of commercial fertilizers, Part 1.
No. 2. *Cotton experiments with varieties and fertilizers.
No. 3. *Analyses of commercial fertilizers, Part 2.
No. 4. *Fertilizer test with wheat.
*Annual report.
No. 5. *Methods of keeping sweet potatoes.
No. 6. Analyses of commercial fertilizers.
No. 7. *Experiments with wheat and oats.
*Annual report.
No. 8. Investigation chemical composition cotton seed meal.
No. 9. *Experiments with Irish potatoes.
No. 10. *Notes on varieties of beans.
No. 11. Analyses commercial fertilizers, Part 1.
No. 12. Co-operative soil tests of fertilizers.
No. 13. Analyses commercial fertilizers, Part 2.
No. 14. Experiments with corn.
*Annual report.
No. 15. Fertilizer experiments with corn.
No. 16. *Experiments with tomatoes.
No. 17. Analyses commercial fertilizers.
No. 18. *Fertilizer experiments with cotton.
*Annual report.
No. 19. *Dairying.
No. 20. Analyses commercial fertilizers.
No. 21. *Technical.
No. 22. *Colic in horses and mules.
*Annual report.
No. 23. *Lameness in horses.
No. 24. Analyses commercial fertilizers, in two parts.
No. 25. *Distemper in horses and mules.
No. 26. *Founder in horses and red water in cattle.
No. 27. *Wounds and their treatment.
*Annual report.
No. 28. The sweet potato as a starch-producer.
No. 29. Analyses commercial fertilizers.
No. 30. Determination of starch in the sweet potato.

No. 31. Hog cholera and swine plague.
No. 32. Protection and improvement of worn soils. Annual report.
No. 33. *Test of dairy methods and apparatus. Comparative tests of butter-fat.
No. 34. Sugar beets.
No. 35. Analyses commercial fertilizers.
No. 36. *Diseases of plants.
No. 37. *Wheat.
No. 38. *Asparagus rust in South Carolina.
No. 39. *Suggestions to auxiliary clubs.
No. 40. *Farm manures for cotton.
No. 41. *Rice blast and a new rice smut.
No. 42. *Varieties of cotton.
No. 43. Analyses of commercial fertilizers.
No. 44. *Corn.
No. 45. Analyses of commercial fertilizers.
No. 46. *Cotton.
No. 47. A chemical study of the Sea Island cotton plant.
No. 48. Broad and narrow tires.
No. 49. Strawberries.
No. 50. *Tuberculosis of cattle.
No. 51. *Silo construction and silage.
No. 52. *Pig feeding.
No. 53. Analyses of commercial fertilizers.
No. 54. Analyses of commercial fertilizers, Part II.
No. 55. Feeding rice meal to pigs.
No. 56. *Wheat.
No. 57. Fungicides.
No. 58. Grapes.
No. 59. *Chemical investigation of the rice plant and of the products and by-products of the rice industry.
No. 60. Analyses of commercial fertilizers.
No. 61. *Corn.
No. 62. Capons and caponizing.
No. 63. Chemical investigation of sweet potatoes.
No. 64. Analyses commercial fertilizers.
No. 65. San Jose scale.

No. 66 Feeding corn stover and dehorning milch cows.
No. 67. *Stock feeding.
No. 68. Chemical study of Sea Island cotton seed.
No. 69. *Brown rot of peaches and plums.
No. 70. Analyses commercial fertilizers.
No. 71. New method of preserving sweet potatoes.
No. 72. *Texas fever, Part I.
No. 73. Analyses commercial fertilizers, Part II.
No. 74. *Experiments with poultry.
No. 75. Cotton culture.
No. 76. *Bermuda grass.
No. 77. The standardization of sulphuric acid.
No. 78. The nature, determination and distribution of the pentosans in the Sea Island cotton.
No. 79. A rotation study.
No. 80. Analyses of commercial fertilizers.
No. 81. Artificial incubation of chickens.
No. 82. Analyses commercial fertilizers.
No. 83. Practical experiments with preventives of peach borer.
No. 84. One horse farm.
No. 85. Commercial fertilizers.
No. 86. Tobacco culture in the South.
No. 87. Analyses commercial fertilizers.
No. 88. Sorghum as a syrup plant.
No. 89. *Sanitary conditions in home and on farm.
No. 90. Texas fever, Part II.
No. 91. Coast experiments.
No. 92. Analyses commercial fertilizers.
No. 93. Grasses and forage plants.
No. 94. Analyses commercial fertilizers.
No. 95. The milk scales, milk sheet and Babcock Test.
No. 96. Tea investigation, Part I.
No. 97. Analyses commercial fertilizers.
No. 98. Analyses commercial fertilizers.
No. 99. Analyses commercial fertilizers.
No. 100. Analyses commercial fertilizers.
No. 101. Analyses commercial fertilizers.
No. 102. Analyses commercial fertilizers.

No. 103. Coast experiment.
No. 104. Analyses commercial fertilizers.
No. 105. Analyses cotton seed meals.
No. 106. Anaylses commercial fertilizers.
No. 107. Analyses commercial fertilizers.
No. 108. Analyses commercial fertilizers.
No. 109. Notes on varieties of apples.
No. 110. Analyses commercial fertilizers.
No. 111. Analyses commercial fertilizers.
No. 112. Analyses commercial fertilizers.
No. 113. Analyses commercial fertilizers.
No. 114. A wasting disease of young cattle.
No. 115. Analyses commercial fertilizers.
No. 116. Methods of spraying cucumbers and melons.
No. 117. A comparison of wheat brand and cotton seed meal for milk production.
No. 118. Gathered cream plants.
No. 119. Analyses commercial fertilizers.
No. 120. *Cotton experiments.
No. 121. A preliminary report on the blast of rice.
No. 122. *"Calf Scours:" A new method of treatment.
No. 123. Forage crops grown at Coast Land Experiment Station.
No. 124. *The "Williamson Plan" of corn culture.
No. 125. Report: Water content, melting points and keeping quality of butter.
No. 126. Analyses commercial fertilizers.
No. 127 Alfalfa or lucrene.
No. 128. *Stock feeding.
No. 129. Improvement of the wood-lot.
No. 130. Methods of eradicating cattle ticks.
No. 131. Cotton seed meal and corn silage as a ration for dairy cows.
No. 132. Rotundifolia grapes.
No. 133. Report of Coast Land Experiments.
No. 134. *The San Jose Scale.
No. 135. *The Williamson plan in 1907.
No. 136. The manufacture of starch from sweet potatoes.

No. 137. Hook-worm disease of cattle.
No. 138. Analyses commercial fertilizers.
No. 139. Milk fever: Its prevention and treatment.
No. 140. Some conditions influencing cotton production.
No. 141. Treatment of plant diseases and injurious insects in South Carolina.
No. 142. Stomach Worm disease of sheep and young cattle.
No. 143. Some injurious orchard insects.
No. 144. Celery.
No. 145. Fertilizer experiments with cotton.
No. 146. Sweet potato work in 1908.

Respectfully submitted,

JOHN N. HOOK,
Secretary and Librarian.

THE CORN AND COTTON ROOT LOUSE IN SOUTH CAROLINA.

Owing to the large acreage in cotton and corn these crops have for many years furnished an unlimited food supply for the insect enemies partial to them and consequently these pests have increased in numbers of individuals and species. To the already large number of insect foes ravaging these crops in our State we must add another, viz., the notorious corn root louse, which during the last two years has made a distinct impression on the cotton and corn planters in South Carolina.

Historical.

This insect was first recognized in this country by Walsh in 1862. On the last of May of that year he investigated a report from a farmer of Rock Island, Ill., who had discovered large numbers of minute insects on the roots of corn in one of his fields stating that these pests had destroyed from one-half to three-fourths of the crop to such an extent as to necessitate replanting. Walsh obtained many wingless specimens from which he bred fifteen winged females. He noticed many small brown ants working among the aphids.

As a corn root pest this aphis has been investigated in Illinois since 1883 by the office of State Entomologist and our present knowledge of this insect in the corn belt of the North

we owe to Dr. Forbes and his various assistants.

The first positive printed recognition of any kind of a root louse on cotton as a pest, so far as the writer can learn, is found in Prof. Sherman's bulletin, "Insect Pests of Cotton," North Carolina Experiment Station. Prof. Sherman under date of September 24, 1909, wrote us that the first complaint that seemed positive reached his office about 1902 or 1904, although he did not get it positively identified until 1908. This pest seemed to be very injurious in North Carolina in 1907.

A number of complaints from this State reached this Station during the season of 1908, principally from Marion and Sumter counties but the season had so far advanced that the investigations in this State were seriously handicapped for that year.

Field Stations.

Immediately upon receiving the earliest reports of injury in the spring of 1909 this division established a temporary field station at Marion where the best conditions for the prosecution of these investigations appeared to exist. Like the preceding season this work was continued co-operatively with Prof. Webster, in charge of cereal and forage crop insect investigations of the Bureau of Entomology, U. S. Department of Agriculture. Mr. Thomas of this division proceeded to Marion on May 15th to establish the laboratory and make certain preparations for the investigation. He did excellent work but owing to heavy field work at that season it was necessary for him to proceed to Colleton County on May 28th to investigate another problem and Mr. G. G. Ainslie took charge of the Marion laboratory and continued throughout the season of destructiveness.

Identity Determined.

On May 27th corn which had been planted between and near infested cotton rows at Marion was dug up and in several instances the roots were found infested. Ants from the same nest were found working on the roots of both species of plants and their tunnels led from the roots of one plant to those of the other. The lice on the corn roots were all half-grown larvae and spuriae showing that they had been carried there and were not migrants from elsewhere.

Life History.

Until these investigations have been carried considerably further only an approximately correct life history can be given based on the investigations of entomologists in other States. The insect passes the dormant season in the egg stage in the earth and probably only in the nests of one or more of the different species of attendant ants discussed in another portion of this report. In spring, when the seed leaves of some of the earliest food plants open these eggs hatch and the young maintain themselves on these plants. All the specimens hatching from eggs are wingless females, the following generations, born as living young, having a variable percentage of winged forms. The last generation in autumn is bisexual, i. e. males and females are produced. These are wingless and live in the soil like the rest of the females, laying the eggs in which the winter is passed. In some details the life history in this State will, no doubt, be found to vary some from that given above but this is yet to be determined by further investigations.

Description.

Although considerable variation in color may occur among the individuals of a given colony of root aphids the following general description * by Prof. Webster will answer for all practical purposes: "The color is bluish-green slightly whitened by a waxy bloom. The body is oval and on the anterior part of the back are two short, slender, rather conspicuous cornicles or tubes, either standing erect or projecting slightly backward. The winged female has a black head and brownish black thorax, the abdomen being pale green, with about three marginal black spots and numerous small dark specks over the surface. The antennae are dark with paler tinge at articulations, and the legs are mostly black. The only form of male known is wingless."

Many of the young lice may be comparatively colorless, while the older individuals vary from a rich velvety blue to a bluish white color. The following method of examining a colony was employed by Mr. Ainslie: "When examining a colony an iron rod is placed at an angle into the ground well below the plant and the earth raised by forcing the exposed

*Circ. 86, Bur. Ent., United States Dept. Agr.

end of the bar downwards. In most cases the dirt falls away without seriously disturbing the colony. The migrants run first and are easily observed owing to the light glints on the wings. The spuriae are recognized by their large size, globular form and dark color, the large pupae having a pinkish tinge on their wing pads."

The colonies vary in size and occasionally are very large. Mr. Ainslie on May 1909, estimated a colony of one hundred aphids to be composed on an average as follows: 5 spuriae, 10 pupae, the rest too young to determine whether or not they would acquire wings.

Distribution in South Carolina.

During 1908 this insect was first reported on cotton at Marion. The report was investigated on July 8th, when the principal infestation had passed over. After considerable searching only a very few lice could be found on the roots of corn. Ants were in attendance but not numerous. Similar observations were made on corn at Spartanburg on June 3rd and on various dates at Clemson College.

During 1909 the damage was more severe over a wider area. Besides the heavy infestation in Marion County, reports of injury were received from Sumter, Saluda, Colleton and Lee Counties. In the eastern part of Lee County the louse was reported from several places. It is stated by planters that the stand is often spoiled by cold nights. On one plantation visited by Mr. Ainslie on June 7th, he was told that it was first noticed in May, the first two weeks of which were cold and wet, and that it never troubles except in cold, wet weather.

The louse was equally bad on the drier as well as in moister localities on this plantation, apparently not favoring any kind of soil. The principal infestation occurred in one field in which the loss was estimated at one-third of the stand. With the exception of those plants stunted by the louse the cotton was ten to twelve inches high. A portion of the infested area occurred on land that had been well fertilized with stable manure and the foreman suggested that manuring favored the louse. While it seems probable that it might facilitate the work of the ants in making their burrows it should not be interpreted as an

argument against manure, the value of which is well known. * Some lice were found on several plants about a foot high around which the ants were working. No pupae were seen and only one migrant, there being but few lice on the main stalk. Most of the lice were deep in the ground and mostly on the fibrous roots. While numerous, none of the colonies were large, owing to the small roots, it being noticed on one good sized plant dug up, the lice were about ten inches below the surface and about six inches from the main stem with no lice on the main stem.

On June 29th a reported case of cotton root louse was investigated near Sumter. The work of the louse was in evidence. The stand was irregular, the cotton having died in spots varying from fifty to one hundred feet in diameter. Plants dug in various parts of the plantation showed the burrows of ants in the soil about them.

The attendant ants, *Laisus niger americanus, P. dentata comutata* and *Lasius clavigor* were present, the former being the most common.

Inquiries about Ridge Spring in Saluda County, on June 23rd would show that the lice were present and had been injurious. It appears that cotton is not damaged ever year, but is mostly injured on sandy or light land in cold damp springs.

Seasonal Injury.

An examination of the cotton about Marion on May 26th showed that the louse was very abundant and widely distributed. Every field of cotton examined was more or less infested; in many places the cotton was either dying or dead in spots. The lice occurred on any portion of the plant below the ground, frequently on the main stem and again in little bunches anywhere along the roots below the crown. At this time many of the lice were pupae, a few spuriae and an occasional migrant being present. The colonies usually contain from three to twenty-five individuals, although on some plants they are very large. On one plant two hundred insects in all stages were counted. They were mostly small and covered a portion of the stem below the ground over a distance of 1 1-2 inches.

On a badly infested cotton plant the leaves turn red and finally all that is left of the plant is a dry stem an inch long and

*See remedial measures.

difficult to locate. The portion of the plant below the soil attacked turns black and dries up, whereupon the lice gradually move down to the fleshy roots.

An examination of corn on this date at Marion showed the lice present mostly in the pupal form. No migrants were observed and if any had reached maturity their absence at this time could only be accounted for by assuming that they left as fast as developed.

In one field of cotton examined at Marion on May 29th fully 90 per cent. of the stand was infested. Though well distributed on the roots of corn, the lice were not especially numerous. While nearly every stalk in some rows was mined by ants, the burrows had been somewhat obscured by a heavy rain three days before. The lice present were occasional migrants, a few spuriate and pupae, the majority of individuals being larvae in all stages. The colonies were smaller than on cotton and better distributed on the root system.

Examination of corn on May 31st showed lice somewhat less numerous, those present being mostly large larvae nearly grown. One migrant was found with three young larvae beside her. The colonies are smaller than on cotton and a smaller number of pupae present. The lice occur usually at the bases of the roots of the main root system and on the smooth stem above it. Sometimes they occur on the lateral roots some distance away from the stem, but rarely ever as low as the seed.

On June 5th they were becoming scarce very rapidly on cotton. There were few pupae and winged specimens were almost absent. On most plants it was possible to find small groups of larvae and some spuriae. In most cases the stalk below ground had turned black a distance varying from one to four inches and this portion appeared shriveled and any lice present occur below this part of the plant usually on the more fibrous roots. Plants exhausted beyond the power of producing new roots had been deserted by the lice.

On this date it was also noticed that the lice were leaving the corn much the same way as cotton. The colonies were small, migrants and pupae scarce, and occurring mostly on the lateral roots. The principal damage seemed to consist in dwarfing the corn.

On June 14th the cotton showed very few aphids. The weather was moist and many of the injured plants were putting out new lateral roots and were reviving. Whatever lice were present were well out on the small fibrous roots. Replanted cotton had opened the first leaves but no lice were found on it.

Examination of cotton on June 26th showed very few lice and these were deep underground on some of the fibrous roots. Those present were spuriae with larvae—no pupae or migrants were seen. The aphids had practically left the cotton.

It was found that they had left the corn as completely as the cotton and as far as could be determined left both plants for other food plants.

Associations of Ants and Aphids.

The mutual association between ants and aphids is almost a matter of common knowledge; it is the most significant factor in controlling the pests. Upon beginning the investigations at Marion on May 17th, 1909, Mr. Thomas found, as was expected, that the root aphids were heavily attended by ants. The ants had their nests in the rows along with the infested cotton and corn. Upon being disturbed the ants picked up and carried away the wingless forms of lice but in no case was an ant seen to carry a migrant. The most common species was the corn field ant *Lasius niger americanus*. The nests of the ants at this time were usually small and contained a comparatively small number of individuals. The soldiers were numerous and active. They were running about with their jaws open ready to bite when an opportunity presented itself. The nests extended into the ground a distance of eight to ten inches and were well supplied with tunnels and galleries containing larvae and pupae.

On May 27th, at Marion, Mr. Ainslie found another species of ant, *Lasius claviger* attending lice on the roots of Ambrosia artemesifolia. Though resembling *L. niger americanus* in general habits, they were of a golden yellow color and larger and when disturbed gave off an offensive odor.

On May 29th, Mr. Ainslie also found an ant *Pheidole vinelandica*, near the laboratory at Marion running about and attending the lice on the roots of corn. The entrances to their burrows were just wide enough to admit a spuria of the root

louse. Several soldiers were found. These were larger than the workers but smaller than those of *L. niger americanus.* These small ants were found mining about six or eight consecutive hills of corn. Most of the hills were dug but not all had lice. On one stalk occurred a migrant which, it appeared, had its wings eaten off by ants. Her wings were chewed down to ragged stumps. She was feeding and had produced several young. Several lice were dropped in the vicinity and they were taken by the ants into their burrows, the ants backing in, carrying the louse after them. They took them into burrows about ten inches from any corn plant.

Examination of corn roots on May 31st showed about an equal number of lice in possession of *L. niger americanus, P. dentata comutata* and *Pheidole vinelandica.* The latter species had full charge of one of the largest colonies of lice yet seen on corn roots. In size its soldiers resembled the workers of *L. niger americanus.* A large spuria was dropped for the purpose of determining whether these small ants could carry a large louse. The ant first discovered the louse walking and tried to quiet it by stroking it with its antennae, then seized it with its mandibles, placing one above the thorax, the other below. Although the louse was dragged successfully over smooth ground, the ant could not manage it where the surface was rough and the louse held with her feet. Another ant came to its assistance, but they could not agree as to the direction and wore themselves out trying to drag the louse in two directions at the same time. While the louse appeared passive for some time, after too much handling she walked off by herself and the ants finally abandoned her. The young lice were sought for by the ants and easily handled.

On June 4, 1909, on a hard level sand walk along one of the streets of Marion at about 7:00 o'clock P. M., Mr. Ainslie found several colonies of *P. Vinelandica* swarming. The colony consisted in most cases of three to ten holes of varying sizes situated in an area usually not more than two or three feet in diameter. Each colony was distinct from the others. An ant picked up in one part of a colony and dropped in another part of the same colony seemed perfectly at home and entered the holes without hesitation. An ant taken from one colony and

dropped in another ran wildly around and though frequently not attacked, it appeared very nervous until out of the colony. All these ants at this time were swarming in great numbers on the flat sand space surrounding the entrance. There were hundreds and even thousands of workers in each colony running around on the sand. Soldiers were also to be seen occurring at the rate of about one to every one hundred workers.

Winged males and females were grouped around nearly every hole but upon the approach of a person they would gradually enter the hole. None of these were seen further than a few inches from the hole nor were any seen flying. Some appeared to be of a lighter color than others as if more recently hatched.

When a colony of ants is disturbed they do not seem to know what to do. They run about, pick up a louse and carry it some distance and then drop it for another and finally leave altogether. In carrying a louse they grasp it at the sides of the thorax and just in front of the abdomen with their mandibles, squeezing it just enough to hold it. The head of the louse is usually forward in the direction the ant is moving and they do not seem excited.

Observation on infested cotton stalks near Wysacky on June 7th showed the ant tunnels running below the ground near the stalk, many of them branching and leaving the main stalk. The ant tunnels enlarge into small pockets traversed by fine roots on which may occur one or more spuriae and a colony of larvae of the lice. Mr. Ainslie dug a considerable number of plants and found many lice in the earth at the tips of the roots. During this examination the occurence of a migrant with a young larvae on an otherwise infested plant was not found making it appear that in this case no migrants left one cotton plant and migrated to another, but that the ants were the sole agents for distribution.

Food Plants.

During these investigations careful attention was given to the food plants of the root aphid, our records being principally from the vicinity of Marion. In nearly all cases one or more of the species of ants mentioned in this paper were in attendance, the most common being L. niger americanus. The following plants were identified by Prof. G. G. Ainslie:

Name of Plant.	Date Observed.	Remarks.
Ambrosia artemisiifolia	May 26, 1909 May 28, 1909	Aphids scattered along main tap root—some small colonies ten inches below the surface.
Linaria canadensis	May 26, 1909 June 1, 1909	Infestation light.
Gnaphalium purpureum	May 26, 1909 June 14, 1909	A common weed, commonly infested.
Helenium tenuifolium	May 29, 1909 June 14, 1909 June 25, 1909	Lightly infested.
Anthemis cotula	May 29, 1909	Roots covered, all forms present most abundant on large roots near crown.
Erigeron canadense	May 29, 1909 June 1 & 2, 1909	A favorite host plant.
Erigeron ramosus	May 29, 1909	Lightly infested.
Lepidium vulgare	May 29, 1909	Plants examined in infested cotton field were well stocked—winged form present.
Diodia teres (Poverty weed)	May 31, 1909 June 5-14, 1909	A common plant. Lice abundant where growing near infested plants.
Aster sp.	June 2, 1909	Lice abundant.
Xanthium canadense	June 1, 1909	One good sized colony—no migrants.
Bean (Red Valentine)	June 1, 1909	Infested when growing near infested cotton plants. These plants when observed had not been there long enough for a generation of lice to develop. They must have been placed there by ants.
Plantago cristata	June 3, 1909	Infested; plants abundant.
Echnichloa glauca	June 5, 1909	Several specimens found in various stages.
Ambrosia artemesifolia Ragweed	June 5, 1909	Fair sized colonies on plants growing in infested cotton fields.
Krigia virginica	May 24, 1909	Well infested.

The seeds of different varieties of plants which had been planted near infested corn rows at Marion gave the following results with regard to infestation.

Name of Plant	Date Observe.	Remarks.
Erigeron canadense	June 1, 1909	Infested. On one plant near cotton that had died from lice all stages of the lice found. Soil honeycombed with ant burrows.
Mushmelon	June 5, 1909	Plants near infested cotton well provided with lice. Mined extensively by L. niger americanus. Several spuriae have group of young showing that they can flourish in the plant.
Turnip	June 5, 1909	Few plants up. Few lice on turnips near infested cotton plants.
Squash (White Scallop Summer squash)	June 5, 1909	Few plants up near cotton. One spuria found feeding contentedly. Plant growing slowly; if thrifty it would probably be a more favorable host plant.
Ragweed	June 5, 1909	Plants about 3 to 7 inches high. Usually infested by fair sized colonies having all forms present.
Cowpeas	June 3. 1909	Lightly infested with all stages except migrants. (No heavily infested cotton near).
	June 5, 1909	Lice less numerous than a few days previous. It appears that this is not a favorable food plant.
Bean	June 5, 1909	Planted near cotton. A few small larvae of lice found. This appears to be but a temporary or probably an unfavorable host plant.
Cucumber	June 5, 1909	Ant burrows around roots connect with those around nearby cotton roots. No aphids.

Along the row of cotton planted with sweet corn, Mr. Ainslie examined several plants on June 3rd. He found an abundance of the lice on sweet corn though not in all cases. In every case it was noticeable that where a corn plant stood alone it was more likely to be heavily infested than where it stood close by a healthy cotton plant. This corn is now about two inches high. A kernel or more was planted as close as possible to each cotton plant in the row so now where a corn plant is alone it means that a cotton plant has died. Under these circumstances the corn plant is almost surely infested with lice. On this young corn it frequently happens that the

lice are well down in the ground on the main tap root below the seed. The surface roots have not yet started.

The lice are attended by both P. dentata comutata and P. vinelandica, the latter seems to control more hills than the former'.

There is usually some sign of ant work around the cotton but not around the infested corn. This also helps to show that the lice are brought from the cotton to the corn, the ants still using the old entrance at the cotton stalk.

All forms of lice are found and some good sized colonies.

Name of Plant.	Date Observe.	Remarks.
Sweet corn	June 5, 1909	Quite generally infested by the lice.
	June 3,	On plants three inches high near infested cotton, lice were abundant and migrants numerous. No entrance near corn plants.
Mustard	June 5, 1909	Only a few plants up on this date near infested cotton. On a few plants a few small larvae and lice found. Ant tunnels around mustard connected with those around cotton. The mustard seems too young.
Eupatorium capillifolium (Dog fennel)	June 1, 1909	Clean plants set near infested cotton rows May 20th, by W. A. Thomas. Many plants infested with all stages of lice, being worst near heavy infested cotton.
Radish	June 3, 1909	Plants have first leaves extended A colony of lice, mostly larvae and young pupae on roots growing near badly infested cotton, evidently carried there. No opening except near cotton plant.
Watermelon	June 3, 1909	Plants have just opened their first leaves. Lice abundant in all stages near infested cotton.
	June 5, 1909	Lice abundant and contented on plants near infested cotton. All stages present.
Young corn Field)	June 5, 1909	Plants near older corn plants show scarcely any lice. Those present are mostly pupae.
Young cotton	June 5, 1909	But few plants seen and these were mined but no lice.

Natural Enemies.

During the investigation of this Division there were no natural enemies of the lice discovered.

Recommendations for Controlling Corn and Cotton Root Louse.

Rotation.

It has been found that the corn root louse is most injurious in localities where crops are not rotated. Where the rotation of farm crops is practicable it is most important factor in the control of this pest. In this State where the insect is most injurious there has been little effort at rotation other than cotton and corn both of which are food plants of this louse. An isolated field of cotton in Marion County which was seriously infested and heavily attended by ants had been cropped as follows: 1905, corn; 1906, no crop but weeds; 1907 and 1908, corn; 1909, cotton. In other cases investigated, it was found that seriously infested cotton fields had been in corn the preceding year. In any rotation in localities where the cotton root louse is injurious the sequence of corn and cotton on the same land should be avoided. It may not always be possible to institute a crop rotation to suit the conditions, hence other relief measures are given and every farmer must adapt these to his own conditions.

Stirring the Seed-bed Before Planting.

The first colonies of young root aphids in early spring are begun on the roots of weeds and young grass, this being the only food available before corn and cotton are up. If the seed-bed is frequently stirred after plowing and before planting it will destroy these volunteer plants upon which these early colonies depend for subsistence; it will furthermore disturb and break up the organization of the ant colonies and kill some of the various stages of ants and lice as well as isolate unhatched eggs where they are not recovered by the ants. This operation involves extra labor but it is effective against these pests besides being a proven agricultural practice.

Winter Plowing.

This is probably the most practical method for this State on farms where no crop rotation is easily adaptable for controll-

ing this insect. Unlike the conditions in the northern States these lice may be found on the roots of various volunteer food plants late in the fall. An examination of the fields at Marion by Mr. Thomas on Oct. 1st, showed light infestation in corn roots that were still green and attended by the corn field ant, *L. niger americanus*. The lice were abundant on the roots of Diodia teres not only in previously infested corn and cotton fields but almost everywhere where the plant occurred. They were heavily attended by L. niger americanus. No evidence was found showing that the eggs had been laid or that they were being taken care of by the ants. Thorough fall and winter plowing should be very effective in destroying the aphids and thoroughly disorganizing the ants.

FERTILIZATION.

Stable Manure.—Although it was suggested in one instance where barnyard manure was used that it appeared to help the louse, in the light of experience elsewhere this would seem improbable except that manure in the soil might under some conditions facilitate the burrowing of the ants attending the lice. It has been shown in the past that on well manured land the injury by corn root louse is less than on adjoining land with no manure. It has already been stated that the season of injury extends to about June 25th. It is therefore recommended that this period in the growth of cotton and corn be assisted by the application of a quick acting fertilizer, as nitrate of soda, to stimulate the growth of the plants.

CULTIVATION.

Frequent cultivation during the beginning of the crop season would undoubtedly prove beneficial.

SEED TREATMENT.

The treatment of seed with some palliative substance has been experimented with by several investigators which in most cases, however, have proved unfavorable. Such a substance must possess the advantage of easy preparation and application; it must be repulsive to ants and not injurious to the seed. Dr. Forbes has obtained encouraging results with a mixture of lemon oil and alcohol during one season at least in treating seed corn before planting. This division is at

present testing this substance on cotton seed. It is to be expected that the results obtained with such a preparation will vary some with the weather and soil conditions but it is hoped that this or a similar method can be employed successfully on land where other measures seem impracticable.

A. F. CONRADI, Entomologist.

Stomach Worms, Hookworm and Other Parasites of The Digestive Tract of Ruminants.

Sheep raising in some sections of this country and especially in the South is seriously menaced owing to the twisted wire worm (Haemonchus contortus). This parasite may also be injurious to young cattle, and as a calf pest it has been principally studied by the present station veterinarian and zoologist. During these investigations which cover a period beginning Oct. 1907, it was found that the cattle hookworm (Monodontus phlebotomus) was present, doing the principal damage during the last part of the season of 1907 and during January 1908, while in some cases it was practically the only parasite present at postmortem. The preliminary results of the investigation of hookworm disease at this College and Station is reported in Bulletin 137 of this Station; the following report being an account of progress including all of the various parasites encountered and identified during these investigations. This work has been carried on co-operatively between the Divisions of Veterinary Science and Zoology of this Station.

(*Stomach Worm Haemonchus contortus.*)

Life History.

The full grown worms live in the alimentary canal of sheep and young cattle, occurring normally in the fourth stomach and during postmortem of animals that died (not killed) may be found more or less abundantly in the small intestines. During postmortems of sick animals killed, the great scarcity or complete absence of these worms in the small intestines make it appear that during the life of the animal this species does not normally frequent the small intestines. While in the alimentary canal they mate and the females lay minute eggs of an elliptical shape, varying in length from 75 to 95 microns,

and in width from 43 to 54 microns. In shape and general appearance, the eggs of a number of species of the strongyloid worms resemble each other so closely that it is difficult or totally impossible to distinguish them. When the eggs of both stomach worms and hookworms are numerous it may be noticed that the stomach worm eggs are inclined to be wider near the middle than at the ends, while those of the cattle hookworm, for the most part, have an equal width and are rounded at the ends.

When the eggs are laid they are rarely segmented, the inner portion being of a uniform, granular appearance, though sometimes segmentation may be found in the eggs near the extremities of the oviducts, before they are laid. From the time they are laid in the intestines until they are passed from the animal in the faeces, segmentation occurs and it is rare to find eggs in freshly collected manure that have not reached the morula stage. The eggs are very sensitive to cold, heat and drouth. They may be killed by freezing temperature as well as by exposure to drouth for a short time only. There was no development in cages containing heavily infested moist manure kept in incubator at a temperature of 100 to 105 degrees F. In a temperature of 88 degrees to 98 degrees F. hatching occurs in from 24 to 48 hours, and as the temperature falls the time required for hatching increases. There was no development in infested manure dropped Nov. 14, 1908 and left in the pasture under natural conditions of temperature and moisture on the shady side of a tree. A small percentage of eggs hatched outdoors during the warm weather occurring during the third week of November, 1908. When the temperature falls to 60 degrees in the laboratory incubation may require from several weeks to a month, and at 40 degrees all activity is practically discontinued.

Before hatching the young worm is completely formed in the egg and its movements may be observed through the microscope. The young larvae are very active, feeding on organic material about them. They vary in length from 325

*Klein, S. C. Expt. Sta. Bull. 114.

to 425 microns, and in width from 18 to 22 microns.

The alimentary canal and mouth are easily observed, the former consisting of an oesophagus and intestine. Like the eggs, the young worms are sensitive to cold, heat and drouth. In many of the outdoor cages there was very little development from eggs laid in the fall even when the winter was mild at Clemson. Fresh infested manure collected Nov. 2, 1908 and kept be reported later.
under field conditions, developed a few larvae during the warm weather of latter November, while the development in the check cages kept indoors was heavy. Some of this manure was collected again on May 2, 1909 and examined when live ensheathed worms were abundant. These had their alimentary canal well filled.

In from six days to two weeks, depending on the temperature and moisture the young larvae reach their complete growth in the free state, the maximum growth taking place when the temperature ranges from 90 degrees to 94 degrees F. At a temperature of from 60 degrees to 75 degrees F. this may require two to three weeks. Only one molt was observed, but from micrometer measurements it would appear that there are two before the final molt in the free stage.

When the free larvae become full grown they reach what may be called a pupal stage. Most of them secrete a covering about themselves, inside of which the activities of the larva may be observed. This covering is called a sheath and when completed practically seals the enclosed larva. The ensheathed worm is from 625 to 800 microns in length and has the rear end elongated into a sharp point. When quiet the point of the tail of the larva is about 80 microns from the point of the sheath and the head about 40 microns from the interior end of the sheath.

Longevity of Worms and Eggs.

The length of time the various stages of the worms may remain alive varies greatly with the environment and probably with the individuality of each worm to some extent. As has

*Detailed accounts of temperature investigations will be reported later.

already been noted the young worms and eggs are very sensitive and are easily killed by heat, cold and drouth. When they reach the ensheathed stage they are more resistant. The ensheathed stage is here designated as the pupal stage which consists of one or the other of two forms, (a) ensheathed, (b) quiescent. In the ensheathed form there is a distinct enclosure about the worm as shown in Fig. 7

In the quiescent form there is a thickening of the cuticle but no distinct sheath and so far in our experience the quiescent form though very scarce, appears to be more resistent than the ensheathed. In moist cultures in the open cages in the laboratory to which no water was added, during the winter of 1908, the ensheathed worms were all dead after a period of 93 days. Fresh material heavily infested, collected Oct. 14, 1908, was put in cages outdoors after 85 per cent had ensheathed. The cages were made of glass open at top and bottom to give as nearly out-of-door conditions as possible. The maximum hatching occurred on Oct. 29, 1908. The ensheathed larvae attached to the glass wall of the breeding cage were examined at frequent intervals and after February 17th no live worms could be found. The faecal material in this cage was weathered and no examination made.

On Nov 11, 1908 fresh infested faecal materiial was collected and placed in open lantern globes in protected spots on hillsides where no cattle or sheep had been kept previously. This material was examined at frequent intervals. Most of the ensheathed worms on the glass walls were dead on May 15th but those that remained in the manure were active with the alimentary canal well filled. Examination showed that those worms remained in the manure live longer and later ascend like the rest. It was particularly noticed that manure kept for seven months in open outdoor cages and which had to be soaked in water for some time before a slide could be made for examination, contained more live, full-grown free worms than the breeding cage walls. A number of the active worms were the quiescent form above referred to. Drought is fatal to eggs and young worms, but if the culture media contains enough moisture to enable the worm to become full-

grown it appears to be more advantageous to remain in a continually dry environment than where conditions are changeable-moisture and drought alternating.

Fig. 1
Hookworms mating in the intestine. (original)

Fig. 2
Eggs of stomach worms, greatly enlarged. (original)

Fig. 3
Eggs of cattle hookworm, greatly enlarged. (original)

Fig. 4
Young stomach worm in egg about ready to hatch, greatly enlarged. (original)

Height to Which Worms Will Rise.

Observations in the laboratory in various cages and under different conditions showed that the majority of ensheathed worms will become quiet within five inches above the surface of hatching media. A series of experiments was then undertaken with a view to determine the effectiveness of plowing. The experiments were made as follows:

(a) Heavily infested faeces buried 1, 2, 3, 4, and 5 inches in sand.

(b) Heavily infested faeces buried 1, 2, 3, 4, and 5 inches in sandy loam.

(c) Heavily infested faeces buried 1, 2, 3, 4, and 5 inches in sandy clay.

The material buried in sand was not seriously handicapped —the young worms coming to the top without any apparent obstruction. The sand and soil in all experiments was kept approximately as moist as the soil under out-of-door conditions and packed as nearly as possible like newly plowed ground. The rising of the worms was severely handicapped in the sandy clay when buried at a greater depth than 2 inches. This was due to the finer particles in this soil and the consequently greater compactness, especially after water had been added on the surface. Where water was added to the clayey

soils copiously and the surface allowed to dry no worms reached the surface. Where a very dry mulch, such as fine dry soil, or air-slaked lime, is placed on the surface few young worms come through but become ensheathed in the moist earth beneath the mulch.

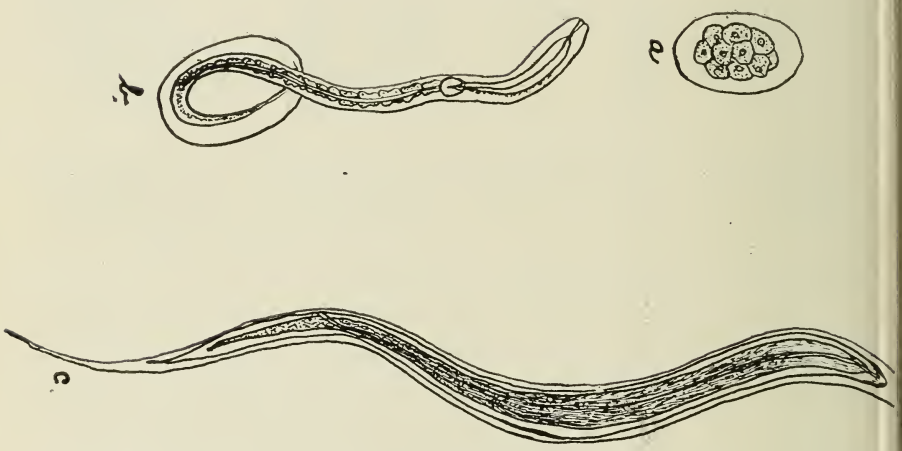

Fig. 5
Several stages of the human hookworm, U. duodenale; a, egg; b, egg hatching; c, young worm in sheat greatly enlarged; (Redrawn from Eighteenth An. Rep. Bur. An. Ind.)

Cultivation cannot be depended upon to relieve the situation under ordinary field conditions but where very deep plowing is practiced, the worms would be handicapped in coming to the surface.

Food of Full-grown Stomach Worms.

We have not fully determined the principal food of the adult stomach worms in the alimentary canal. From examinations of the alimentary canal we are not justified in assuming that the principal food is either blood or injesta. Upon examining an animal postmortem, the worms are rarely attached to the walls of the stomach. They occur mostly in the mucous secretions between the injesta and the mucous mem-

brane. It is probable that their principal food consists of this mucous just referred to.

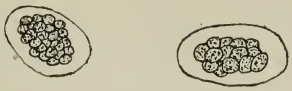

Fig. 6
Hookworm eggs six months old, greatly enlarged. (original)

Were the worms the direct cause of the death of the animal it seems that the animal should respond to heavy infestation, which during the investigations of the past season was not the case. Furthermore, the small number of worms occurring in

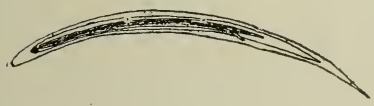

Fig. 7
Ensheathed stomach worms, greatly enlarged (original)

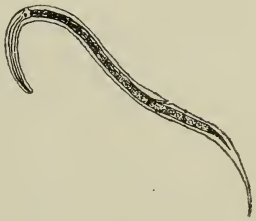

Fig. 8
Ensheathed hookworm, greatly enlarged (original).

some of the animals could not have been the sole cause of death, either by blood sucking or the consumption of injesta, were the last two assumed.

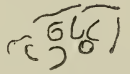

Fig. 9
Ensheathed stomach worms as seen on breeding cage wall with hand lens, enlarged. (original.)

Relation of Maximum Infestation to The Time of Death or Recovery of Animal.

Upon examining Fig. 10 there will be found a diagramatic representation of the egg records of every animal in the experiment from early spring when the calves were put to past-

ure until late in the fall of 1908 when infestation had almost eliminated itself and the animals that had been sick were improving. This diagram was obtained by making daily faecal examinations with the microscope—the examinations having been made mostly by Mr. W. A. Thomas under the zoologist's directions. While an occasional faecal examination for eggs would have little value in determining the extent of infestation of the animal, yet when it is repeated systematically reliable interpretation can be made as was clearly shown when comparing the faecal egg records with the conditions at time of postmortem of animals that died. A bird's eye view of the diagram shows that the heaviest infestation occurred during the month of June. Another increase of infestation took place with some animals in September.

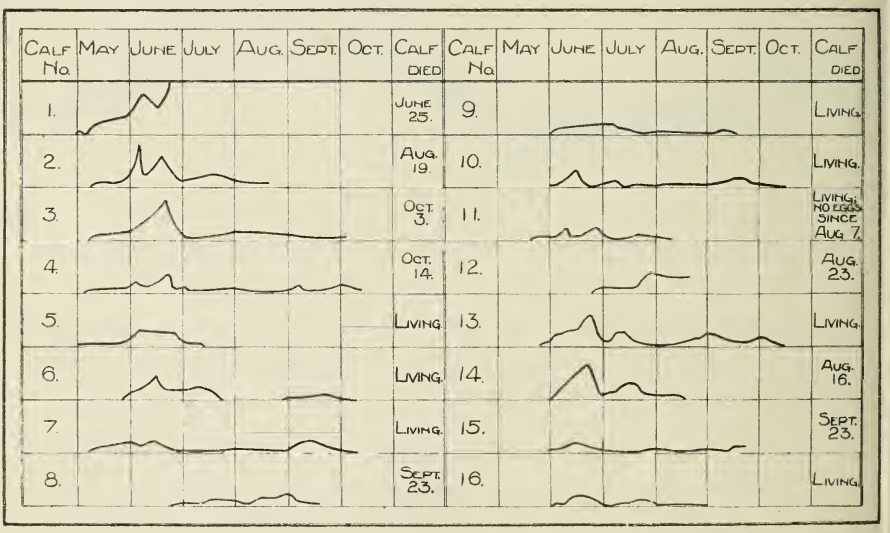

Fig. 10
Diagram representing faecal egg records of calves (original).

Seasonal and Postmortem Records of Calves Used in Experiments in 1908.

Calf No. 1, put in lot A, on May 1, 1908, when six weeks old gave the heaviest egg record of the season. Before transferring to the experimental lot it was kept on a pasture free

from parasites and on May 1st was in good condition. About May 28th it was losing flesh and on the morning of June 23rd was droopy. There was no anaemic condition. It died on June 25th.

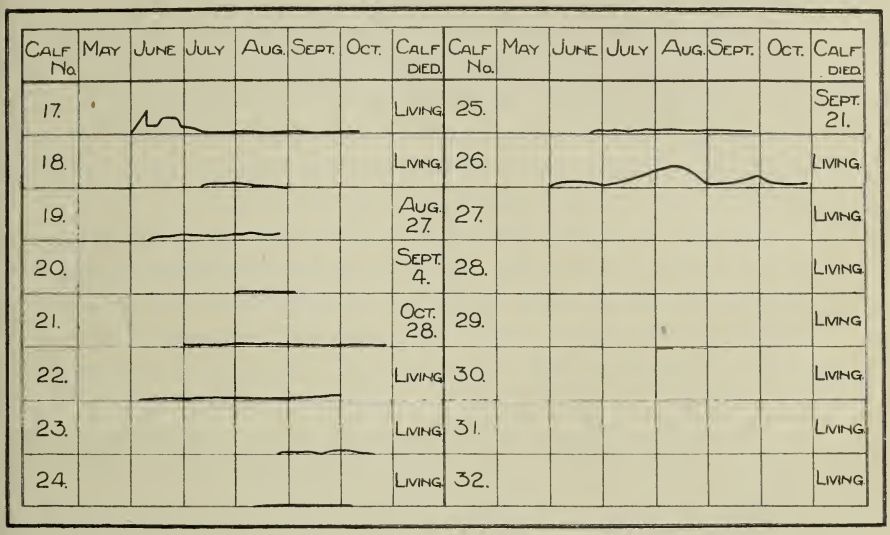

Fig. 11
Diagram representing fæcal egg records of calves. (original)

Parasites at Postmortem: The fourth stomach as well as the small intestine, including the duodenum, contained no parasites. Trichocephalus affinis was very abundant in the caecum, and all were dead. The coagulated blood in the caecum contained Haemonchus contortus in medium numbers,—all dead.

Calf No. 2.—This calf was put on lot A, on May 2nd. Although the animal gave a faecal egg record almost equal to No. 1, the maximum occurring during the first week of June with a recurrence during the third week, it was generally in good condition until the early part of August when it showed signs of droopiness and was gradually declining. On August 17th, it was found down and unable to raise. On the morning of the 19th it was killed and a postmortem held by Dr. Barnett.

Parasites: In the fourth stomach there were a few stomach

worms, while a few hookworms were found in the small intestines. Examination of the faeces showed the egg record to be the same as that of the 18th.

Calf No. 3.—Put to lot A, May 1st, as a very young calf. The maximum egg record occurred during the third week of June, after which it was continually very low until the death of the animal. This calf died at 9 A. M., Oct. 3rd, but unfortunately no postmortem could be made before 5:30 P. M. Only a few stomach worms were found in the fourth stomach and one hookworm was seen in the small intestine. A portion of the lungs had solidfied and the upper part of the trachea was partially filled with clotted blood.

Calf No. 4.—This animal was placed in lot B, on May 4th, when about a week old. It showed the maximum egg record during the third week of June, the infestation throughout the season being rather low. The calf thrived until Sept. 21st, when it began to fail. On Oct. 14th, being in a very weakened condition it was killed and examined postmortem.

Parasites: The stomach worms were numerous in the pyloric region of the fourth stomach while a few hookworms were found in the small intestines.

Calf. No. 5.—Put to pasture May 4th, when little over a week old. It was always in fine condition, never showing any effects of infestation.

Calf No. 6.—This calf was put in lot A, on May 5th, as a young suckling calf. It developed nicely and although there was an active infestation from May 27th to July 25th, it never showed any effects therefrom.

Calves Nos. 7, 9, 10 and 11 although having low, prolonged egg record, all thrived and never showed any effects of infestation.

Calf No. 8.—Put into lot B, as a suckling calf May 2, 1908. It never prospered and during the week beginning Sept. 13th, seriously began to fail. Died during the night following Sept. 22nd.

Postmortem.—At 9:30 Sept. 23rd. The blood of the animal was less anaemic than is usual while it was in little better flesh than ordinary. All the vital organs with the exception of the alimentary canal were in good condition.

The injesta of the stomachs showed that it had eaten almost normally. Stomach worms numerous in the fourth stomach, while owing to circumstances the duodenum was not carefully traced. In handling the small intestines a large number of hookworms escaped and were picked with the forceps from the operating table and taken to the laboratory in 30 per cent alcohol. *Oxyrus ovis* was more numerous in the secum than in any animal posted during the last year. Four specimens of *Filaria cervina* were taken from the postmortem table which evidently had escaped from the peritoneal cavity. None of *these specimens* of *F. cervina* were encysted. Outside of the alimentary canal there were no hemorrhagic conditions, but the greater portion of the small intestines and secum were heavily punctured with hemorrhagic spots. It is impossible to make a comparative estimate of the percentage of hookworm and stomach worm infestation. The hookworm infestation, however, was heavy.

Calf No. 12 was put in lot A. May 7th as a suckling calf. It gave a very low egg record from June 25th to July 25th when there was an increase which held uniform until August 23rd, when the animal died. At post-mortem there was found to be a moderate infestation of stomach worms in the fourth stomach.

Calf No. 13.—Put into lot A, May 10th, as a suckling calf. Although the animal gave a very active egg record throughout the season, it thrived.

Calf No. 14.—Put to pasture same as No. 13. This animal gave no eggs until the second week in June when infestation increased continually, reaching its maximum June 17th, when there was a rapid falling off until June 25th. The egg record continued very low and had almost disappeared on August 16th, when the animal died. This calf had been holding its own until August 10th when it began to fail. On the morning of that date it was down, having scoured for several days. It died about 11 o'clock and examined postmortem immediately after death.

Parasites:—The fourth stomach was moderately infested with stomach worms, a few specimens of *Trichocephalus affins*

occurred in the caecum, no hookworms.

Calf No. 15.—Gave a low, prolonged egg record similar to Nos. 8 and 9, and died Sept. 23rd. Put to pasture May 7th, as a young calf. The animal held its own until Sept. 15th, when it began to fail. Postmortem examination showed about one-half handful of stomach worms, while hookworms were scattered throughout the small intestines.

Calves Nos. 16 and 17 were placed on lower lot F, adjoining lot B, shown in diagram. The condition of the lot was very similar to lot B, except that no cattle had been kept on it during previous years. These calves were allowed to run with a milch cow throughout the season. While the egg record of No. 16 was very light and extended over a period of about ten weeks, the egg record of No. 17 was a low, prolonged one. Neither calf showed any symptoms of illness at any time, although they thrived no better than most of the calves of lots A, B, and C.

Calf No. 18 gave practically no egg record and thrived. It was placed on lot A, about the middle of April.

Calf No. 19 gave a low egg record, beginning June 14th and remaining uniform until death on August 27th.

Calves Nos. 20 and 21 gave very low, the latter a prolonged egg record, it being understood that neither of these calves died from the effects of parasites.

Calves Nos. 22, 23 and 24 are all living. All gave low, prolonged records and thrived.

Calf No. 25.—Put in lot B, as a suckling calf on May 27th, 1908. This calf held its own till August 25th when it showed signs of failing. On the morning of Sept. 21st it was down. While it did not offer to eat grass it ate cotton seed meal. Died at 3:30 P. M.

Postmortem—Held by Dr. Powers. Stomach worms were numerous in the fourth stomach and occurred scatteringly a distance of about 15 ft. through the small intestine. Scattered through the small intestines were occasional hookworms. Around the first stomach were hemorrhageic peritoneal areas and occasional hemorrhagic spots along the intestines with inflammatory areas in the caecum.

Calf No. 26. Put in lot B as suckling calf May 28, 1908. During the greater part of August and most of October the egg record was moderately high and the animal showed signs of failing, the oedematous swelling of intermaxillary space being very pronounced. On Oct. 25th, the animal was given up to die during the next few days. About Nov. 1st the calf was distinctly gaining and continued to gain. Nothing unusual was noticed except that No. 26 with another calf, No. 7, had the freedom of lots B and C, which contained many bearing oak trees. The acorns began to fall profusely, beginning on Oct. 26th owing to wind and showers. It was noticed that these two calves ate little between feeds except these acorns which were devoured greedily.

Nos. 27, 28, 29 and 30 were placed on upper lot Sept. 9th, 10th and 12th respectively and 31 and 32 during the first week in October as suckling calves. These are recorded as fall calves. They gave no egg records nor did they ever show symptoms of infestation.

It would appear that the animal dies some weeks after the heavy infestation. Examples of this are calves Nos. 2 and 3. Both gave a very heavy egg record during June, yet both died at a low egg record, No. 2 seven weeks and No. 3 twelve weeks after the maximum egg record. While this is not true with calf No. 1, yet in examining the postmortem records it is found that there was considerable inflammation which may have been due to causes other than stomach worms.

From the above it follows:

(a) In case of two calves of the same age on same pasture and giving about the same egg record, one may die, the other survive.

(b) In case of two calves of same age on same pasture, one having much higher egg record than the other, the animal with the lower egg record may die while that with the higher egg record may not even show symptoms of being affected by the infestation.

(c) In case of two calves, one having a low egg record of short duration, the other a low, prolonged egg record, the

former may die, the latter survive.

Method of Infection.

It has been stated that only the fully ensheathed larvae are capable of infection; the eggs nor newly hatched larvae when taken into the body being unable to continue their development. If this is the principal mode of infection then it is at once apparent why the young worms rise on blades of grass taking the greatest number of chances for drying up if not swallowed by a host animal. Young worm-free calves put on an infested pasture show eggs in small numbers in the faeces in about four weeks and it appears that this is approximately the time required for the young worms to complete their growth after they are taken into the body. How easy it is for an animal to become infected has not been determined. In our artificial infection experiments we were unfortunate. During the fall and winter of 1907 repeated attempts were made to infect young calves by drenching with cultures of ensheathed and free larvae, the former being by far the most abundant. The cultures used were all very rich in material. No systematic records of these drenchings were kept as they were not considered a part of the experiment as the sole object of the procedure was to get an infested calf for another purpose. At the outset it was assumed that artificial infection might be easy, and it was only when after some time no results were secured that artificial drenching was taken up experimentally.

Beginning Nov. 10, 1908, a seven months old calf at the animal husbandry barn of this Station was selected for this experiment. After normal infection had been determined by frequent faecal examination this animal was systematically drenched with material rich in worms which was obtained from experimental calves from the low creek bottoms near the College farm barn. Fully 80 per cent of all material used for drenching was ensheathed while the remaining 20 per cent contained young larvae of various ages not yet ensheathed. This condition is scarcely possible to avoid because in every breeding cage there is a varying percentage of stragglers. The animal was drenched on the following dates:—Nov. 27th and 30th; Dec. 1st, 2nd, 3rd, 7th, 8th, 9th, 10th, 12th, 16th,

17th, 18th, 19th, 22nd and 23rd. The manure was collected till January 15th, 1909 and examined microscopically. Owing to the very light infestation the faecal material was also placed in a vial daily and a comparison made of the number of young worms appearing on the cage wall and in the manure. There was no increase in the number of eggs and while the number of young worms appearing on the cage walls fluctuated in the usual manner, they were at no time more numerous than in the check cages.

On January 21st, 1909 this calf was killed and a post-mortem held. There were a few stomach worms in the fourth stomach, but no other parasites in any other portion of the digestive tract. The dozen (few more or less) stomach worms present gave us no encouragement that the feeding of ensheathed larvae had in this case increased the infestation. The same number of stomach worms might be found in almost any calf killed and examined at this Station.

Seasonal Occurrence of Injury at Clemson College.

Upon examining the diagram in Fig (12) it will be found that during the season of 1907 the death rate due to stomach worms was very small. In that year the principal injury was caused by the hookworm as represented by the dotted line E and occurred during the latter part of December and during January 1908. The maximum death rate among calves during the season of 1906 due to stomach worm occurred in October,* the dying season extending from the middle of September to the early part of November and is represented by the line D. Line C shows the dying season of five sheep used in the experiments, the death occurring principally during August.* In 1908 the dying season of calves began in the latter part of August and extended over about an equal period as that of 1906, the heaviest death rate occurring in September.

Relation of Moisture to the Dying Season.

Again examining the diagram in Fig. (12) it is noticed that the rainfall in 1906 was very heavy, the total for the year

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*S. C. Expt. Sta. Bull. No. 142.

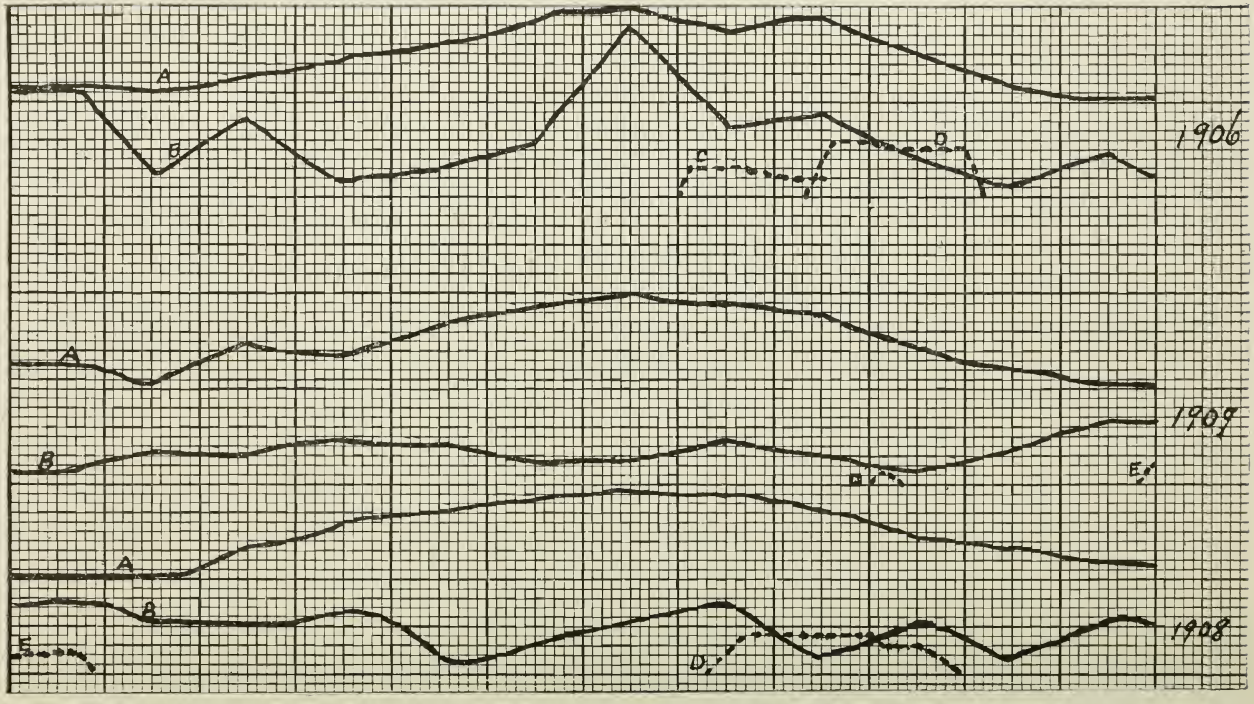

Fig. 12
Diagram showing dying season, rainfall and temperature. (original)

being 76.83 inches of which 39.61 or over 1-2 of the total fell during the months of June, July August and September. The maximum death rate from stomach worm follows this heavy rainfall. There are no deaths from hookworms recorded during that year.

The rainfall during 1907 was only 41.57 inches and was quite uniformly distributed throughout the year—the total for the months of June, July, August and September being 12.63 inches. The death rate was very small occurring in early October. The rainfall increased in November and reached its monthly maximum in December, which was followed by the dying season from hookworm extending from December 27th, 1907 to January 25th, 1908.

In 1908 the rainfall was heavy, the total being 69.69 inches, of which 20.57 inches fell during the months of June, July, August and September, the precipitation in September being only 1.82 inches. The death season followed this heavy precipitation.

Considering the data in connection with laboratory experiments it is evident that the percentage of death during a single season is governed to a great extent at least by the amount of precipitation during the main growing season, from June to September. Moisture is very important for the successful development of the young stomach worms and hookworms. The mortality of the young worms during the last two winters under out-of-door conditions has been very heavy yet there is a small per cent. that will survive under very adverse conditions of drouth or moisture. The young spring calves coming to pasture during April graze little during the first week or two. The heavy grazing begins in early May. Abundant

moisture during May and June will make the conditions for the development of the young worms very favorable and may account for the high egg records in June. It is important that

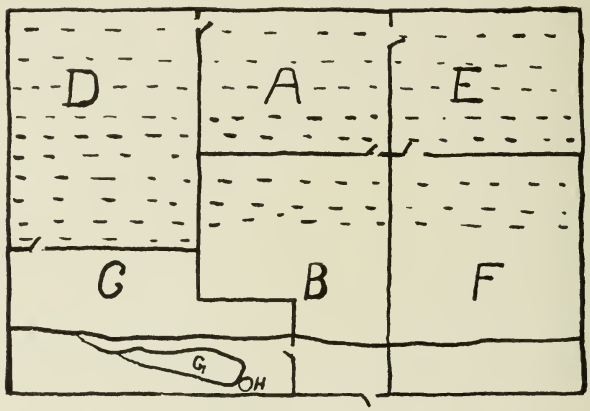

Fig. 13

Experimental lots used during this investigation; shaded portion indicates high and dry land, unshaded portion is a low creek bottom. H, is a spring feeding a swamp G, which drains into the creek. On lots C and B the heaviest death rates occurred. (original)

the pasture on which young cattle are kept are dry and clean. Low swampy places are favorable for the development of these parasites even in dry weather. Abundant pasturage and nourishing food are necessary during late summer and fall.

Effect of Worms on Spring and Fall Calves.

The principal injury is done to spring calves. The trouble becomes pronounced through August and September depending on the amount of moisture present during the spring and summer months. During the three years past no fall calves died from intestinal parasites at this Station, nor did they ever show any signs of attack. During the past season all calves introduced on lot A as young suckling animals after August 20th did not develop any symptoms. They showed a very light egg record but thrived. This might be accounted for by the scarcity of pasture and the shorter grazing season of the animal.

Calves 16 and 17 were placed on creek bottom land lot F, with a nursing cow and kept there throughout the season.

This lot received drainage only from lot E. These calves never developed any symptoms of the disease but were not particularly thrifty at any time during the season. They both gave a low egg record. It should be stated that this lot was never as heavily infested as lots A, B and C. During 1906 there were three lots viz: DG, AB, and EF. In the spring 1908 high land was separated from the low creek bottom resulting in the arrangement as given in Fig. (13).

Injury in Relation to Age of Animal.

The herd used in these experiments consisted of sixteen calves varying from seven to twelve months of age, and including Jerseys and Holsteins. From this herd four calves died from parasites and the results of these postmortems are already recorded in Bulletin 137 of this Station. The remainder of the herd was transferred from the infested lots to a large high land pasture on April 1st. Several of these calves showed the symptoms of infection at this time, especially one small Holstein, the youngest calf in the herd which at that time was merely holding its own. It did not shed its hair like most of the other calves owing to its poor condition from the effects of the parasites. On April 25th, several calves of the herd became sick and at noon of the 27th one died. Postmortem examination showed no parasites. The youngest calf of the herd died late in the afternoon of same date so that postmortem examination could not be made before dark, consequently the stomach and intestines were removed by Dr. Powers and transferred to the zoological laboratory by the writer, where they were carefully examined, showing a few hookworms. Not a single parasite was found in the intestine, the few hookworms occurring in the fourth stomach. This was the only instance where hookworms were found in the fourth stomach. They were very active and aggressive and the effects of their attachment to the mucous membrane never more noticeable. The point of attachment of the mouth of the worm to the stomach wall showed spots similar to those produced on the skin of a person stung by a poisonous insect. The membrane was swollen, the elevation being about 1-16 inch in diameter, with a dark spot in the center. On Sept.

28th, two other calves of this herd died and were examined by Dr. Barnett and the writer, neither calf showing any worms whatever. On the morning of the 29th another calf that had died the previous night was examined postmortem by Dr. Barnett. He found several hookworms in the small intestine. These were brought to the laboratory and upon examination no eggs were found in the females. From these observations it appears that the strongyloid parasites had been practically eliminated and hence were no factor in causing the deaths of the animals in this herd. The ages ranged from ten to fifteen months, the average being about fourteen months old. When considering the above facts with other postmortem examinations, appearing in other portions of this report, it may be concluded that the intestinal parasites or their injuries mentioned in this paper become eliminated from the animal at approximately fourteen months—sooner in some cases.

Extent Infestation in Relation to Symptoms.

A systemtic faecal egg record was made of all calves in the experimental lots in order to keep informed as to the progress of infestation. As nearly as possible an equal amount of faecal material was examined on each slide, the examinations being similar to those made the previous season and recorded in Bulletin 137 of this Station. While the egg records in the calves examined and 'posted' in 1907 showed the extent of infections as can be seen by examining the postmortem records, during the season of 1908 when a large number of calves were examined, the maximum faecal egg records did not occur when the symptoms and deaths were highest.

Host Animals.

During these investigations frequent examinations were made of the faeces and alimentary canal of animals other than ruminants to determine which are host animals or intermediate hosts. These examinations included material from horses, pigs, cats, dogs, rats, mice, rabbits, poultry and various kinds of wild birds.

Horses.

Faecal examination of horses at no time showed any eggs resembling those of stomach worms, *H. contortus*. Eggs of

Ascaris megalocephala and *Oxyuris curvula* were common in some material.

PIGS.

In the fæcal material of swine the eggs of the kidney worm, *Stephanurus dentatus,* are commonly met with. These eggs resemble those of the stomach worm though longer and hav-

Fig 14.

Eggs of kidney worm of pig, Stephanurus dentatus, greatly enlarged. (original)

ing a greater variation in shape. The adults occur commonly in pigs; in our studies they were found principally in the tissues around the kidney, sometimes accompanied by peritoneal effusions. In some cases active full grown worms were found in the hylus.

Ascaris suilla was found in the intestines of pigs.

RABBIT.

Strongylus sp., Eggs which, with the exception of size, resemble those of stomach worms, are commonly met with in the stomachs of rabbits. These are the eggs of a species of strongylus resembling S. strigosus differing from the latter principally in the form of the spicules which are .5 mm long, lacking the filiform structure as given for S. strigosus.

CATTLE.

Monodontus phlebotomus (Hookworm) occurred in destructive numbers in young cattle during the winter of 1907-8 (See Bull. 137, S. C. Expt. Sta.). During the season of 1908 this species occurred commonly in nearly all the young cattle examined postmortem. In two cases this species was fairly numerous while in one postmortem it was the principal parasite present in the alimentary canal.

Cooperia punctata occurred abundantly in the small intestines of all young cattle 'posted' where M. phlebotomus was fairly numerous or abundant (Bull 137, S. C. Expt. Sta.,) making it appear that these two species thrive under similar

conditions. In a letter of March 12, 1908, Dr. Ransom gives me the following data on this point; "Schnyder (1906) examined carefully for parasites the carcasses of seventeen cattle in Switzerland, in seven of which he found Cooperia punctata. In only one out of the seventeen was H. contortus present and this animal was free both from C. punctata and M. phlebotomus. In two of the animals infested with C. punctata, M. phlebotomus was also present."

Fig. 15.

Eggs of Oesophagostoma inflatum, greatly enlarged. (original)

Oesophagostoma inflatum occurs very commonly in the caecum of young cattle.

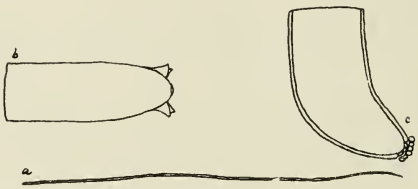

Fig. 16.

Filaria cervina (a), adult, reduced one-half; (c) posterior end and (b) anterior end greatly enlarged. (Drawn from nature)

Filaria cervina.—Several specimens taken from peritoneal cavity in young cattle. In one case the specimen was coiled and encysted, numerous hemorrhagic spots occurring in the neighborhood of the cyst. Fig. 16.

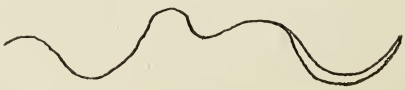

Fig. 17.

Trichocephalus affinis. (original)

Trichocephalus affinis occur commonly in the caecum of young cattle.

Dog.

Filaria immitis.—Several specimens taken from pulmonary artery of dog during postmortem. They had various positions, being either folded or extended.

Spiroptera sanguinolenta.—Taken from an asophageal cyst during postmortem.

Miscellaneous.

Anguillula intestinales was met with in the examination of faecal material from calf lots but host was not determined. *Anguillula sp.* resembling *A. intestinales* was common in manure of hookworm infested calf at Greenville, S. C., on Oct. 16, 1909.

Summary.

I. Biological.

1. Under normal conditions the full-grown stomach worms live in the fourth stomach of cattle and sheep while the hookworms live in the small intestines, being most numerous in the upper portion. In hookworm infested cattle Cooperia punctata is frequently very abundant over the same area as the hookworms.

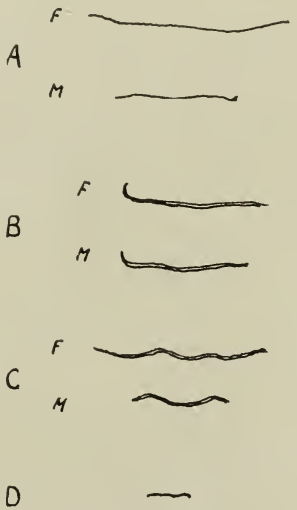

Fig. 18.

Comparative appearance of various worms, natural size. A, male and female stomach worms; B, male and female Oesophagostoma inflatum; C, male and female cattle hookworm; D, female Cooperia punctata. (original.)

2. These species mentioned mate and oviposit in the digestive tract and the eggs are passed out with the faeces. Under favorable conditions of moisture and temperature they

hatch and develop to the infesting stage in from five to two weeks.

3. The eggs of the stomach worm and hookworm resemble each other in size and shape—those of Cooperia punctata being much smaller. These eggs are all sensitive to extremes of heat, cold and drouth, while the infesting stage is much more resistant.

4. A variable percentage of full-grown ensheathed worms may live nine months and show great activity when disturbed.

5. The ensheathed worms may rise on any near [illegible] and remain quiet in an elevated position. A variable percentage does not rise while the tendency of rising is much less in the hookworm than the stomach worm.

6. The minute size of the young worms enables them to ascend through sand or loose soil. They are heavier than water and readily sink.

7. During 1908 the dying season of the animals did not occur during or immediately after the season of maximum egg record.

8. The number of deaths, diseased and healthy animals was not proportionate to the intensity of infestation.

9. The dying season occurred during the latter portion and following rainy seasons in fall and winter.

10. Only spring calves are attacked by the disease.

11. The parasites or their injuries are eliminated from the animal at approximately ten to fourteen months of age, mature cattle not being injured.

12. Experiments during the last two years at this Station have shown that this disease is least dangerous on high well drained pastures. (See Report of An. Husb.)

II. Economic.

1. In view of the experiments carried on by the Veterinary and Zoological Divisions of this Station during the last two years, it is of prime importance that young cattle be kept on high or well drained pasture.

2. The animals should have plenty of wholesome food and especially during late summer and fall when pastures become scant.

The animals should have access to plenty of fresh water, preferably running water, and no muddy or swampy conditions should be tolerated about watering places.

4. During a moist season when the disease is worst the pasture should be changed, always keeping the animals on upland.

5. Intelligent rotation of land is not only important on in- arms but it is one of the best practices on most South farms.

here the raising of late summer or fall calves is prac- it will greatly eliminate this disease, it having been observed in the investigations that at this Station late summer and fall calves were never attacked.

A. F. CONRADI, Entomologist.

COTTON ANTHRACNOSE INVESTIGATION.

Report of Progress.

Introduction.

Since the work of Dr. Atkinson[1] of the Alabama Station and Miss E. A. Southworth[2] of the Department of Agriculture in 1889 and 1890 there has been little work of either scientific or practical importance done on cotton anthracnose. In the mean time the disease has spread to such an extent that it has already crippled individual farmers in many sections, and threatens to jeopardize the production of cotton all over the South. In many cases the past season, the estimated loss of individual farmers has amounted to from 40 to 70 per cent. of the crop. A very conservative estimate of the annual loss in this State would be 1 per cent. of the crop. For the past season this would amount to over $700,000. The comparative scarcity of knowledge of the life history and habits of the fungus, Colletotrichum gossypii, which causes the disease, together with the increase in the amount of damage done

1. Alabama Experiment Sta. Bull. No. 41.
2. Journal Mycology Vol. VI. No. 3.

by it, made apparent the necessity of a careful study of the fungus in its various stages of activity. Such study was begun in the summer of 1908 and has been continued since that time. While the problem is by no means complete, it seems that it will be well to publish here some of the interesting and important things which have come out thus far in the investigation. Upon reviewing the available literature at the time the investigation was undertaken, a number of different phases of the problem presented themselves. What seemed at that time to be the most important of these were (1) The perfect stage of the fungus and its bearing on the problem, (2) The method and source of infection of the bolls, (3) The vitality of the conidio-spores and mycelia of the fungus as they occur on the diseased bolls and stalks in the field, (4) The probability of the fungus being carried in the seed and the effect of this on spreading the disease, (5) The possibility of breeding a strain of cotton that would be resistant to anthracnose.

Since this work was begun, Prof. C. W. Edgerton[3] has discovered and described the perfect stage of the fungus, and, as we have not met with this stage here, I shall simply refer those interested to his article on the subject. It does not seem necessary in a paper like this to give a description of the disease and the various stages of the fungus which causes it, but I simply refer the reader for this to Atkinson and Southworth. With a view, however, of helping those who are not familiar with the disease to recognize it when they meet it, I shall, before taking up the discussion of the experiments as outlined above, give a short description of the disease as it occurs on the bolls. In this paper, I shall use the following common names and terms in general usage, in place of the strictly technical terms:—Boll, the entire fruit or capsule; lock, the individual carpel or lockule; bloom, the part of the flower which drops off immediately after fertilization, and is made up of the corolla, the stamens, and the style and stigma of the pistil.

The Disease as it Appears on the Boll.

Cotton anthracnose first occurs on the outside of the boll

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3. Mycologia Vol. I. No. 3.

as a small dark or purplish spot. This spot usually increases in size as the disease progresses until in some cases it covers one-fourth to one-half of the boll. At any time after such a spot occurs, if the weather conditions are favorable, the whole surface of the diseased area is liable to become covered with a moist, pinkish, pasty-looking mass of spores. This pinkish coloration on such surfaces is very characteristic of the disease. If such bolls are cut open they are found to be discolored and rotten on the inside. If the boll approaches maturity before it is completely destroyed, it will partly open; and the lint and seed will be compact and rotten (See Fig. 1.). Such lint will also be covered in moist weather with pink

Fig. 1.

Bolls badly diseased with Anthracnose.

masses of spores. If the bolls are attacked while they are very small, their development is checked and the whole boll turns black.

Method of Infection.

On the 1st of September, 1908, a number of inoculations

were made with a view of getting some light on the method of infection of the bolls. One hundred and thirty bolls of various sizes were inoculated by puncturing the boll with a sterile needle and then inserting spores from pure cultures into the punctures. From such inoculations the infection seemed to take place almost immediately, the disease beginning to show up in from three to four days, and in from seven to twelve days developing into typical diseased bolls. One hundred and twenty-eight of these, or 97 per cent., produced the disease. Bolls that were punctured in the same way, but not inoculated, did not develop the disease. At the same time. 100 bolls about three-fourths grown were inoculated by spraying with sterile water containing spores of the fungus. The disease showed up on only six of these. The fact that the inoculation took in practically every case where the boll wall was punctured and the fungus inserted, and in only 6 per cent. of the cases where the water containing spores was sprayed on the boll, made it look as though there might be something in the theory which was promiscuously advanced at this time that insects by puncturing the bolls made injuries through which the fungus entered. The season was too far advanced to make further inoculations at this time; so this had to be postponed until the following summer, 1909.

This time the inoculations were begun on the 17th of July, four days after the first flowers had been observed in the field. Ten flowers were inoculated on this date by spraying with sterile water containing spores from pure cultures. This was done in the evening between five and six o'clock of the day that flowers opened. The tube from the atomizer was held so that the spore laden water was forced well down into the flower, and two to four cubic centimeters of this was used in each inoculation. The spraying of this water into the flowers did not seem to disturb their normal functioning, as all of those inoculated, as well as the checks treated in the same way with sterile water, set fruit and developed as rapidly as the ones not treated. Twenty more flowers were inoculated in a similar manner on the 23rd, and seventy more on the 27th of July. Notes were taken on all of these every day for the first two weeks and from then on, every two days. Three of the

first ten became infected. On one of these a small brown spot had developed near the base of the boll on the 23rd, six days after inoculation. This had increased to one-fourth of an inch in diameter by the 25th; and on the 27th, ten days after inoculation, the young boll had burst open, and masses of spores were being produced on the broken surface. When brought into the laboratory and opened, this boll was found to be diseased throughout at the base. The fungus had entered at two points along the line of dehiscence on opposite sides of the boll. About one-half of the basal portion had turned brown, as a result of the disease; and numerous mycelia and a few spores were found in this discolored, diseased portion. Another of these bolls showed a small dark spot on the line of dehiscence near the base on the 28th, eleven days after the inoculation. This increased slightly in size until two weeks later, when it was one-half an inch in diameter and was producing an abundance of spores. This boll had been increasing in size all the while, and was one inch in diameter when collected. The interior was diseased throughout much like the one described above. The third of this lot showed no sign of disease until after it had opened on the 1st of October, seventy days after inoculation. On the 13th of October, when collected, pink masses of spores were observed on the inner wall of the boll. The lint and seed here seemed to be perfectly healthy and mature.

Of the next twenty inoculations made in the same way on July 23rd, seventeen bolls or 85 per cent, became infected. The disease showed up on one of these in three days; on five in six days; on two, in eight days; on four, in eleven days; on three, in eighteen days; and on two, in thirty-six days after inoculation. The high per cent. here was probably due to unusually favorable weather. There was .1 of an inch of rain on the day of inoculation, .2 two days later, .3 two days later, one inch one day later. The weather was partly cloudy during all of this time. This damp, cloudy weather seemed to enable the fungus to get a hold and to enable it to develop more rapidly than with inoculations made at other times. In the majority of these bolls the fungus entered through the line of dehiscence and spread rapidly through the whole in-

terior of the young boll. The diseased mass of the interior of such bolls was brownish to black in color, spongy and moist, but not mushy, as is frequently the case with such rots. By the time the whole interior had succumbed to the disease, pink masses of spores would begin to show up on the surface and a little later, spores would begin to form on the decayed mass in the interior. One rather peculiar thing about these inoculations was the great variation in the rapidity with which the disease developed. Some of the young bolls showed signs of disease in three to six days after inoculation, and a few days later were found to be completely diseased. In other cases,

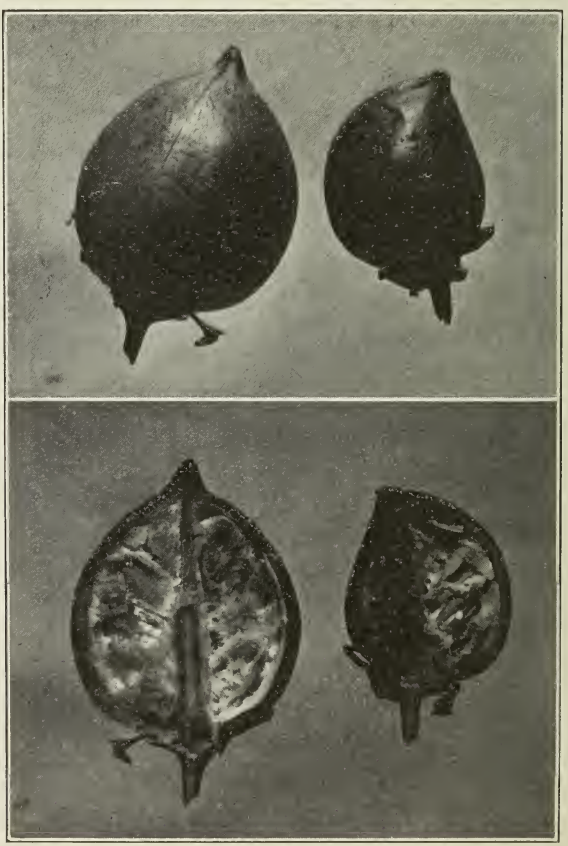

Fig. 2.

Boll to right inoculated with spray of spores of Anthracnose in sterile water. Boll to left, check of same age from same stalk.

the disease showed up within ten to fifteen days, but the bolls

continued to develop and were not destroyed until two weeks to a month later. In some cases, there would be no sign of the disease until a month or more after inoculation and then the whole boll would be destroyed within a few days. Boll No. 11, for instance, showed no sign of disease until thirty days after inoculation, and at that time only two small spots were noticed near the apex on the lines of dehiscence. Three days later, the whole distal end of the boll turned black and the interior was found to be badly diseased. Several others showed up in much the same way as this one (See Fig. 2.). This seemed to indicate that the fungus in some cases enters without leaving any sign on the boll wall,—first destroys the seed and lint on the inside, then attacks the capsule walls, and later forms masses of spores on its outer surface. In other cases, the boll would be attacked first, and the lint and seed would mature before much damage had been done to them. Boll No. 12 showed no sign of disease until it was mature and open, when a number of small yellow areas were observed on the lint. These, when examined, showed the anthracnose spores and filaments. No spores or other signs of the disease were found on other parts of the boll, but spores and filaments were found on the inside of several of the seed which were taken from these discolored portions. None of the checks which were sprayed at the same time with sterile water, showed any infection.

Of the next seventy inoculations made in the same way as above on the 27th of July, twenty-three bolls, or 33 per cent, became infected. The disease here showed up with about the same rapidity and in much the same manner as with previous inoculations. Three of the bolls in this series showed no signs of disease until mature and open, and then spores and filaments were found on the lint and seed, as in the case of No. 12 noted above.

A number of blooms from these inoculations were collected when they had dropped, and placed in damp chambers in the laboratory; and all of these developed an abundance of anthracnose spores. Some of the blooms which were not collected but allowed to fall to the ground and remain in the field on the surface of the soil, produced numerous spores in

from six to ten days after inoculations were made. Where conditions were favorable, spores were produced in this manner on all of the blooms that were inoculated. These blooms dropped in from two to three days after the inoculations were made. It seems that, when they drop the second day after inoculation, this might take place in some cases before the fungus has had a chance to grow through the base of the petals and gain entrance into the young boll.

Young Bolls Inoculated.

On July 28th, fifty one-day-old flowers were tagged. The next day, the 29th, ten of the old blooms were removed, and these young bolls sprayed with sterile water containing spores taken from pure cultures. Ten more of these were inoculated on the 31st, two days later. On account of very heavy rains we could not get in the field to follow this at two day intervals, but ten others were inoculated on August 4th, five days later and ten others on August 7th, and ten others on August 9th. Of the first ten, which were inoculated when two days old, 60 per cent became infected. Of the next ten, which were inoculated when four days old, 40 per cent became infected. Of the next ten, which were inoculated when nine days old, 30 per cent became infected. Of the next ten, which were inoculated when eleven days old, 30 per cent became infected. Of the next ten, which were inoculated when thirteen days old, 50 per cent became infected. On all of these where the disease showed up before bolls matured, diseased spots occurred on the lines of dehiscence, except in four cases where the interior was found to be badly diseased before any signs of disease occurred on the outside. On the young bolls which were inoculated in this way, the disease did not seem to develop quite as rapidly as it did where inoculations were made in the bloom. Of the fifty, six showed up in less than ten days; three, in less than twenty days; three, in less than thirty days; four, in less than forty days; and three, in less than fifty days after inoculation. All except four of the bolls in this lot, however, were completely destroyed by the disease. These four when collected contained nearly mature seed in which spores and filaments of the fungus were found.

All of the inoculations taken up thus far were protected in

no way from outside agencies of infection but were simply sprayed with the water containing spores and left under absolutely normal conditions. Each time checks similar in every respect to the bolls inoculated were sprayed with sterile water and observed same as inoculated ones. In only two cases did disease develop on such checks.

Bagged Bolls Inoculated.

On August 16th and 17th a number of bolls were bagged before the flowers opened; and then, after the fruit was set, inoculations were made. Eight of these bagged bolls were inoculated in the flower on the 27th. Three bolls, or 37 per cent of these became infected. On August 21st, twenty-eight of these young bagged bolls, five days old, were inoculated with spray. Nineteen of these, or 68 per cent., bacome diseased. The bags were kept over these and they were not opened except to make notes on developments of the disease. The disease developed here much the same as in previous inoculations. The high per cent. of these five day old bolls which became diseased seems to indicate, as did the inoculations of young bolls previously referred to, that infection takes place easier when young bolls from two to six days old are inoculated than when the inoculations are made in the flower or on older bolls. This might be explained by the fact that the calyx extends up above and around the young boll at this stage, and makes a kind of cup which holds the moisture. This would furnish ideal conditions for the spores that lodge here to germinate and begin work. The fact that as much disease developed on the inoculated bagged bolls as on those not bagged indicates that insects have nothing to do with the infection.

Young Bolls Inoculated With Puncture.

On August 21st, five bolls, five days old, were inoculated by puncturing the boll wall with a sterile needle, and then spraying with water containing spores from pure culture of the fungus. Four days after inoculation, practically all of these spots were surrounded by purplish areas one-eighth of an inch in diameter. Two days later, these areas were producing spores on the surface, and the whole of the interior of the young bolls was discolored and diseased. Bolls punctured in

a similar way, and sprayed with sterile water, developed no disease. At the same time, five ten day old bolls were inoculated at four points each by puncturing in a similar manner, and inserting spores in the punctures. The disease did not develop quite so rapidly on these, but in a little longer time had done just as effective work. Six days after inoculation, purplish areas, one-eighth of an inch in diameter, were observed around the punctures; and, three days later, these were producing pink masses of spores and the disease had spread to the whole interior. These were collected at this time, and masses of spores were found to have been produced on the immature diseased lint and seed.

On the 15th of September, five bolls about grown but green and apparently two weeks before opening, were inoculated similar to ones above, except punctures were very slight, intended to go only part of the way through the boll. Five points were inoculated on each boll. At twelve of these twenty-five points, the fungus went through the remainder of the boll and infected the seed and lint beneath. These punctures, naturally, varied a little in depth; and, where they did not extend more than half way through the boll, the fungus seemed unable to get through the remaining portion. Where the punctures were deeper than these, the fungus worked its way through into the seed and lint beneath. Where this occurred, the lint and seed would be discolored, assuming a dirty, yellowish color and presenting a moist, slimy appearance. At such freshly attacked places, young mycelia could not be found in the lint hairs but the cells were badly disorganized. The contents were colored yellow and scattered throughout the cells. In places where the fungus had been at work longer, mycelia were found on the inside of the lint fibres. It seems, from a study of these points, as though the secretions from the mycelia must have a toxic effect on the immature hairs which causes the cell contents to break down and become disorganized, after which the mycelia enter the fibres and probably through them gain entrance into the seed coats. The cells of the boll and seed coats which have been penetrated by the mycelia of the fungus are not disorganized as the lint fibres are. Even in these bolls which were about mature, the fungus spread rapidly

among the seed and lint as soon as it had made its way through the walls of the boll.

Miscellaneous Inoculations.

On September 15th, five bolls, one-third to three-fourths grown, were inoculated at four points each, at marked areas, on the surface of the boll, with spores suspended in a drop of water. At two points the fungus was found after seven days, to have gone through the wall of the boll and attacked the lint and seed beneath. Six of these inoculated areas crossed the lines of dehiscence; and, at two of these places, one place each on two different bolls, the fungus went through and started the disease. The fact that a very low per cent. of these inoculations produced infection shows how hard it seems to be for the fungus to get to the inside of the boll. Sections were made of the places where the mycelia did succeed in entering, and the filaments could be seen very clearly in the cells of the boll wall. (See Fig. 3.)

The epidermis was removed from four small areas on each of four bolls which were about grown, and these areas were inoculated with a drop of water containing spores. Two of these bolls were on Burn's Long Staple and the other two on Toole cotton. Neither of the inoculated areas on Burn's Long Staple did more than cause slightly diseased appearance of the inoculated surface. The fungus did not cut through the boll. At two of the places, however, on one of the bolls of Toole, the fungus succeeded in getting through the boll and causing disease. These two points seemed to have been scarred deeper in removing the epidermis than were the others. It would seem, therefore, from these inoculations, that simply removing the epidermis does not help the fungus to gain an entrance into the boll.

Small sections one-half inch square were taken from the boll at two points each on four bolls, and the spores were placed on the lint which was thus exposed. Two days later the lint thus inoculated was discolored and the fungus was seen to be spreading. Four days later when the bolls were collected and brought in, the entire lock which was inoculated, in each case was discolored throughout, and filaments and

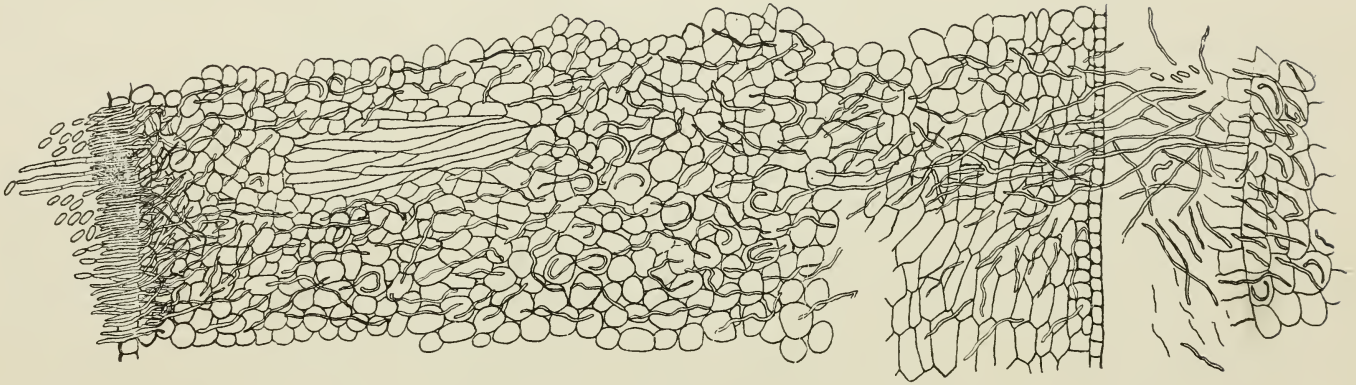

Fig. 3.

Section of young boll, showing the fungus penetrating the hull of the boll, and entering the young seed. Spores are being produced upon the outer portion of the boll hull and upon the surface of the young seed coat.

spores of the fungus were found among the diseased seed and lint.

A small portion of the tip of the apex of eight bolls was clipped off, and spores placed on the clipped surfaces. In every case, after an average of about five days, the fungus entered and spread through the interior of the bolls.

Ten bolls were inoculated with spray just as they were beginning to open. None of these developed disease. All of these inoculations were made in a part of a field where no anthracnose occurred, and since checks in every case remained healthy and developed normally, it seems quite evident that the disease in each case came from the inoculation.

Inoculation of Stems and Leaves.

On July 17th, ten leaves, ten petioles from which leaves had been clipped, and ten scarred places on stems of different stalks, were inoculated by inserting spores with sterile needle. Each leaf was inoculated at four places. None of these developed any disease. The scarred, inoculated places on the stems developed nothing definite. In two cases, however, where such inoculated areas looked rather suspicious, and were removed and placed in damp chamber in the laboratory, anthracnose spores were developed; but in no case were spores found to have developed on these in the field, and sections of tissue scarred and inoculated in this manner showed that mycelia had entered only a little distance beyond the injured tissue. All of the petioles, which were inoculated after the leaves had been clipped from them, developed disease. Two of these were withered and about to drop six days after inoculation, and were brought into the laboratory. The inoculated ends were discolored and indicated the work of the fungus, but no spores were being produced. They were placed in damp chamber, and after four days an abundance of spores were found throughout the distal half of the petiole. Four others held on from ten to twelve days and turned black throughout their length before they dropped. These were producing spores on the clipped end when collected. The scars from which these clipped petioles fell were carefully watched, and as several of them looked suspicious, two were cut off ten days later and brought in, and placed in damp chamber. Anthracnose

developed on each of these. These inoculations were made on two varieties, Toole and Hite's Early Prolific, which, as we have learned since, are very resistant to anthracnose. In spite of this, however, a month after inoculations had been made, two bolls which were located near the inoculated petioles were found to be diseased. No other diseased bolls were found on these or the neighboring stalks. Further experiments along this line will be conducted next summer.

Observations Relative to Infection.

Observations were made in the field here and in a number of other sections of the State on the occurrence and development of the disease. Specimens of diseased bolls were sent in by twenty-eight farmers from all parts of the State and these bolls were used in some cases for laboratory studies. In about 98 per cent of the bolls examined, the location of the diseased spots on the surface of the bolls indicated that the infection had taken place through the lines of dehiscence. In practically all of the badly diseased bolls, pink masses of spores were found on the diseased lint and seed and on the inside of the diseased seed. Bolls of all sizes were diseased. The large majority sent in, however, were found to be about one-half to two-thirds grown. From observations so far, it seems that comparatively few bolls succumb to the disease under natural conditions before they are half grown, and that those that do, drop off and are not noticed by the ordinary observer. One thing that struck me as rather odd, while making observations in various fields where the disease occurred, was that the presence of the disease does not always seem to mean a great loss. In some cases it would destroy one-half to two-thirds of the crop, and in other cases on the same varieties of cotton and under conditions very similar, not more than 2 to 10 per cent of the bolls would be destroyed. The weather conditions and the varieties of cotton used seemed to be in a measure responsible for this. It is rather hard to understand, too, why the disease did not spread more in the field here to bolls adjoining those inoculated, especially in cases where an abundance of spores were developed early in the season. The factors controlling the spread of the disease from one boll to another will be looked into more carefully next summer.

Summary of Inoculation Studies.

(1) The disease always develops from bolls of any age or any variety when inoculated with spores through punctures in the boll wall. On entering such inoculated bolls, the fungus causes the lint at this point to turn yellow and present a slimy, yellowish appearance and the cells of same to become disorganized. Later the mycelia enter the lint fibres and cells of the seed coats and penetrate the endosperm and cotyledons of the seed. Inoculations made in such punctures produced disease in three to five days.

(2) When flowers ten hours after opening were inoculated with spores in water, 44 per cent. of the bolls developing from such flowers were diseased.

(3) 53 per cent. of young bolls inoculated with spores in water became diseased, the per cent. diseased varying with the age of the bolls at time of inoculation, the highest per cent. becoming infected when the bolls were from two to five days old.

(4) The infection both from artificial inoculations, and natural infection, takes place through the lines of dehiscence of the bolls.

(5) The time in which the disease shows up varies, the minimum time after inoculation made with spray being four days; the maximum, sixty days; the average, fifteen days.

(6) Inoculations with spray had no effect on bolls after they were three-fourths grown. It seems, therefore, that natural infection must take place before or about the time the bolls are half grown.

(7) The fungus seems to prefer the lint and seed to any other part of the boll and when it attacks these early in their development, always completely destroys them. When fungus enters seed after they are approaching maturity it seems to penetrate the endosperm and cotyledons.

The Vitality of the Spores and Mycelia of the Fungus Under Field Conditions.

Beginning with November, 1908, old diseased bolls were brought in from the field every two weeks, examined and cult-

ures made from them. During the first three months, it was an easy matter to isolate the fungus from any of the diseased spots on the old bolls. After this time, it was rather hard to find them at all on such bolls, but when these were put in damp chamber they continued to produce spores for two months longer. After this, cultures of the fungus could not be obtained from such bolls. In searching for the fungus in the field, though, it was noticed that the seed in these diseased bolls contained fungus filaments. These, when examined, proved to be anthracnose. Spores taken from such seed from time to time, until the first of June, readily produce cultures of Colletotrichum. These seed when first examined for spores, along in January and February, were found to have quantities of spores on their shriveled and diseased interiors. Later many of the seed were empty, and in others nothing was left but a thin gray layer of filaments and spores just inside the inner seed coat. The last cultures which we were able to get from such seed or from any other source from the field were made on July 20th. After this very few spores could be found anywhere and none of these would germinate. Old diseased bolls and seed placed in damp chamber, after this, failed to produce any growth of the fungus. Numerous fallen blooms were also collected the latter part of July and the first of August, from cotton field where the disease had occurred the previous year, with the hope of finding any fungus which might still be alive in the soil. These blooms had proved such a good medium for the fungus where inoculations had been made that it seemed as though, if the fungus were present and alive in the field, it would develop on these and spread from them to the living portions of the plant. As these blooms decayed on the surface of the soil in the shade of the plants, it seems that they should have formed a good opportunity for the fungus to get a start. Such blooms were also brought into the laboratory and placed in damp chamber, but no anthracnose developed from them. This makes it look as though all of the fungus from the preceding year, except that which was on the living stalks, was dead by August 1st. Examinations and cultures made, still later, from a stubble field which had been in cotton the previous year, but in oats and peas since then, seemed to bear this out.

The Hyphae and Spores on the Inside of the Seed. *

Dr. Atkinson suggested in 1890 that cotton anthracnose might be distributed through seed the same as bean anthracnose, but since that time no work has been done to determine definitely whether the seed are an important factor or not in the distribution of the disease. It seemed, therefore, advisable to make some investigations along this line. Accordingly, in February of this year I made some germination tests with this end in view. The seed which were used in these tests were of the Blue Ribbon variety and were taken from the general lot of seed, from a field in which anthracnose had destroyed 35 per cent. of the bolls. They had, therefore, a good chance to become diseased. I germinated these in lots of a hundred in the laboratory, under sterile conditions, and found that from 5 to 12 per cent. of the seedlings were diseased. Some of these seed were planted in the greenhouse, and the same thing was observed. The disease occurred on the cotyledons before they were unfolded and on the hypocotyl, and from the diseased condition of some of the cotyledons as they were unfolding, it appeared that the fungus must have been on the inside of the seed coats before germination started.

Seed Treatment Tests.

On finding that we had an abundance of infected seed, I decided to treat some of these with various chemicals which are commonly used for seed treatment, and see what the result would be on the fungus. Solutions of copper sulphate, 1 pound to 4 gallons, 1 pound to 10 gallons, 1 pound to 25 gallons, and 1 part to 100; mercuric chloride, 1 part to 100, 1 part to 500, 1 part to 1000; formalin, 1 pint to 10 gallons and 1 pint to 20 gallons were used. The time used for these was with each solution thirty minutes, two hours, three hours, six hours and twelve hours, after which the seed were placed between blotters and germinated. In every case where the seed germinated at all, disease showed up on the seedlings. (Fig. 4.) The per cent. of diseased seedlings ranged from 2 to 12 per cent. of the

*The data secured in this connection have been submitted to the University of Nebraska as thesis for masters degree.

germinations. It seemed to be as prevalent with one method

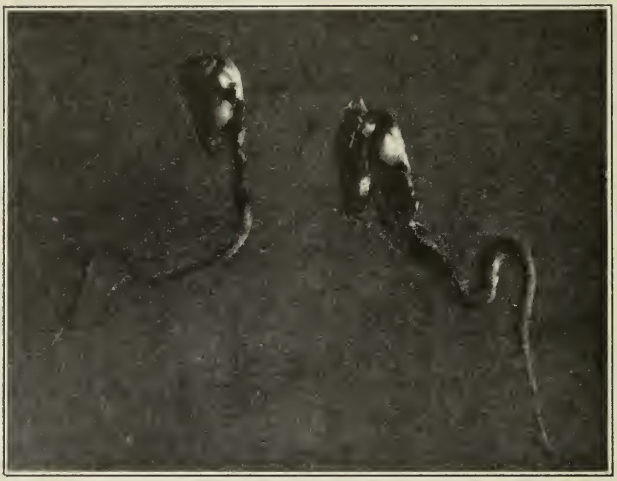

Fig 4.

Anthracnose on seedlings from seed which were treated with mercuric chloride solution 1 to 500 for six hours.

of treatment as another. The amount of disease in the checks was about the same as with the treated seed. This, of course, leads us to conclude that chemical treatment of the seed before planting would have no effect on the disease. In order to carry this still further, however, seed from this same lot were treated with copper sulphate, 1 pound to 10 gallons for six hours, and mercuric chloride, 1 part to 500, for six hours, and planted in the field at a place where cotton had not been planted in three years. Anthracnose occurred here on the cotyledons and stems of the seedlings, apparently, in about the same proportion as has been noted for the greenhouse tests. Owing to the wet, cold weather in April, this cotton was not planted until the 6th of May, and even then, cool nights which followed kept it from growing off as rapidly as it should. The first anthracnose on the bolls was noted on the 15th of August. Other diseased bolls were noted through the patch from time to time. On September 3rd, the field was carefully gone over and diseased bolls tagged and counted. This was repeated every ten days thereafter until the first killing frost, which was

on October 25th. The amount of anthracnose on the young bolls increased perceptibly after this frost, but such increase was not considered in working up the percentages. The seed were planted in rows in the following order in the field:—The first four rows, from seed treated with mercuric chloride; the next four, in untreated seed; the next four, in seed treated with copper sulphate; and then the same series was repeated. A count of the total and diseased bolls at the end of the season showed that from the seed treated with mercuric chloride, 1.42 per cent of the bolls were diseased; from the seed treated with copper sulphate, 1.86 per cent.; and from the checks, 1.42 per cent. This, then, bears out the laboratory tests and shows that such treatment will not reduce the amount of disease. The amount of disease was not as great here in any case as would have been expected under more favorable conditions. The weather was rather dry in August and September and conditions generally unfavorable for the development and spread of anthracnose.

Studies of Diseased Seed.

Sections were made from seed on which the disease occurred in the germination tests last winter, and the fungus was found to have penetrated the tissue of the cotyledons and of the young stems. From this it was evident that the fungus remained in a dormant condition in the seed. The lack of material with a definite history made it impossible to determine at this time how and when the fungus entered the seed. By inoculations and other studies, though, during the past season we have been able to collect some data on this point. Seed in diseased bolls of all ages and conditions were imbedded in paraffine sectioned and examined. Invariably, where the disease had made any progress at all, the mycelia, and in the majority of cases, the spores, were found on the inside of the seed. Where the boll was attacked early in its development, the fungus would completely destroy the seed. In cases, where the infection took place later in the development of the boll, the fungus seemed to continue to develop and grow through the parts of the seed until the seed and lint were mature. Unless the vitality of the seed was completely destroyed before it had reached maturity, the fungus seemed to suspend opera-

tions when this stage was reached. In a number of cases, seed which were mature and apparently healthy were examined and found to be completely honeycombed with the fungus, and in such cases, an abundance of spores were found between the endosperm and seed coats. A section of such seed is shown in Fig. 5 B. Having met with this condition, while following the development of the disease in bolls inoculated, I set about to examine bolls in the field which had become infected through natural agents. Plenty of material was at hand for this purpose, and examinations proved very interesting. A number of bolls which showed very slight effect of the disease were examined. In some cases no sign of anthracnose would be apparent on the surface of the bolls, and the lint and seed would be mature and the boll open, the only indication of disease being a slight discoloration and slight compactness of the lint. Upon examination of such bolls, numerous anthracnose spores would be found in the discolored patches of lint, on the outside of the seed coats, and, in a number of cases, between the endosperm and the inner seed coats. Filaments of the fungus would be found growing through the cotyledons, and when the seed were pretty badly diseased, spores would be produced between the folds of the cotyledons. Spores were produced in such abundance in some cases on the surface of the seed coats of otherwise apparently healthy seed, as to be visible to the naked eye. When the seed coats were removed from such seed, spores and filaments would be found on the inside. In some cases the lint and seed would be mature and to all appearances healthy, except the lint would not open out wide and appear as fluffy as healthy cotton usually does. Fig. 6 shows section of seed from such a boll, and photograph in Fig. 7 shows picture of the same boll. This particular boll was, at first sight, apparently perfectly healthy; but, when examined more closely, it was found that there was a small diseased spot one-fourth of an inch in diameter on one line of dehiscence of the boll. Still further examination showed that the lock immediately beneath this was slightly discolored and not opened out well. The other three locks of the boll were not discolored, but were a little more compact than healthy locks usually are. These seed when examined with micro-

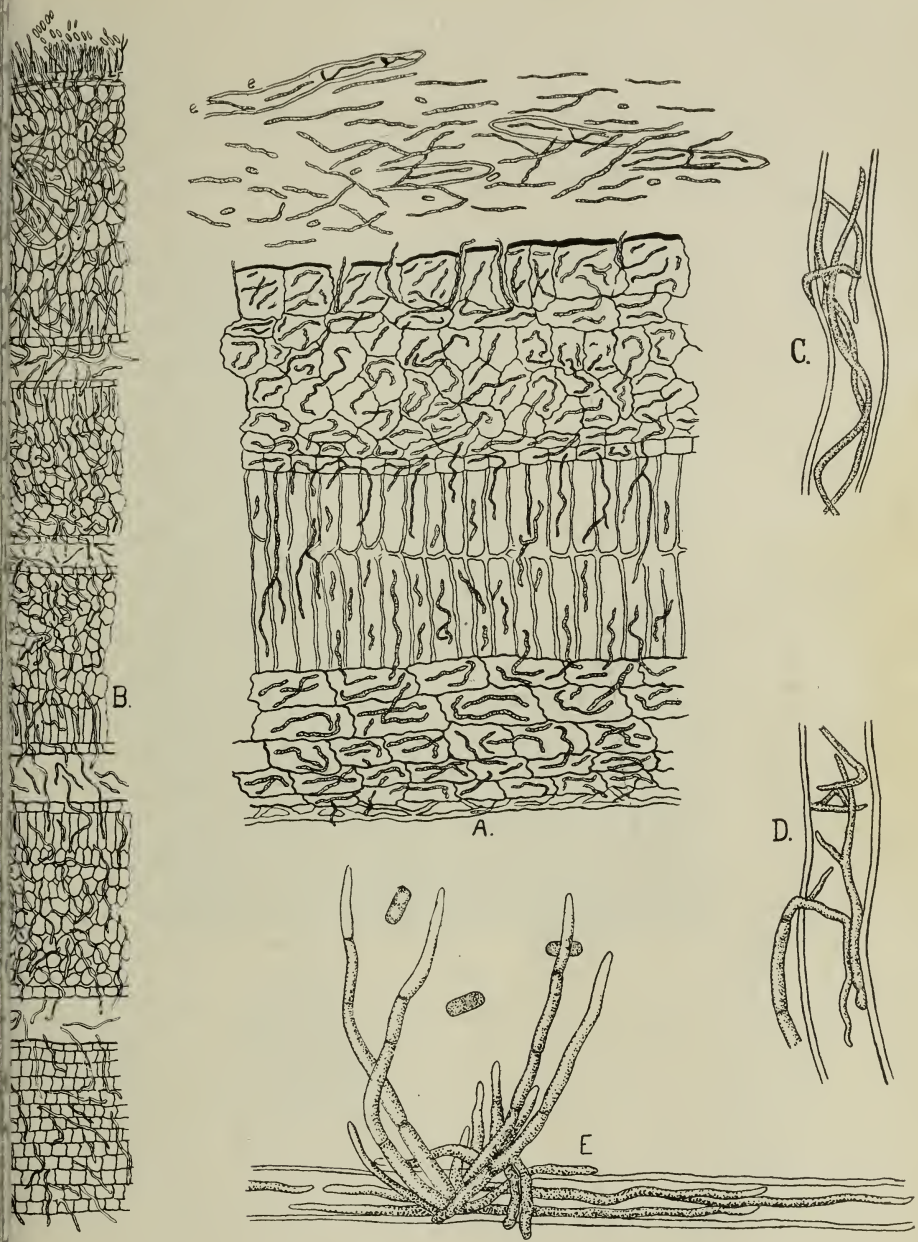

Fig 5.

Fungus in seed-coats. B, Fungus and spores in tissue of seed. C, D, and E, Fungus growing in lint fibers.

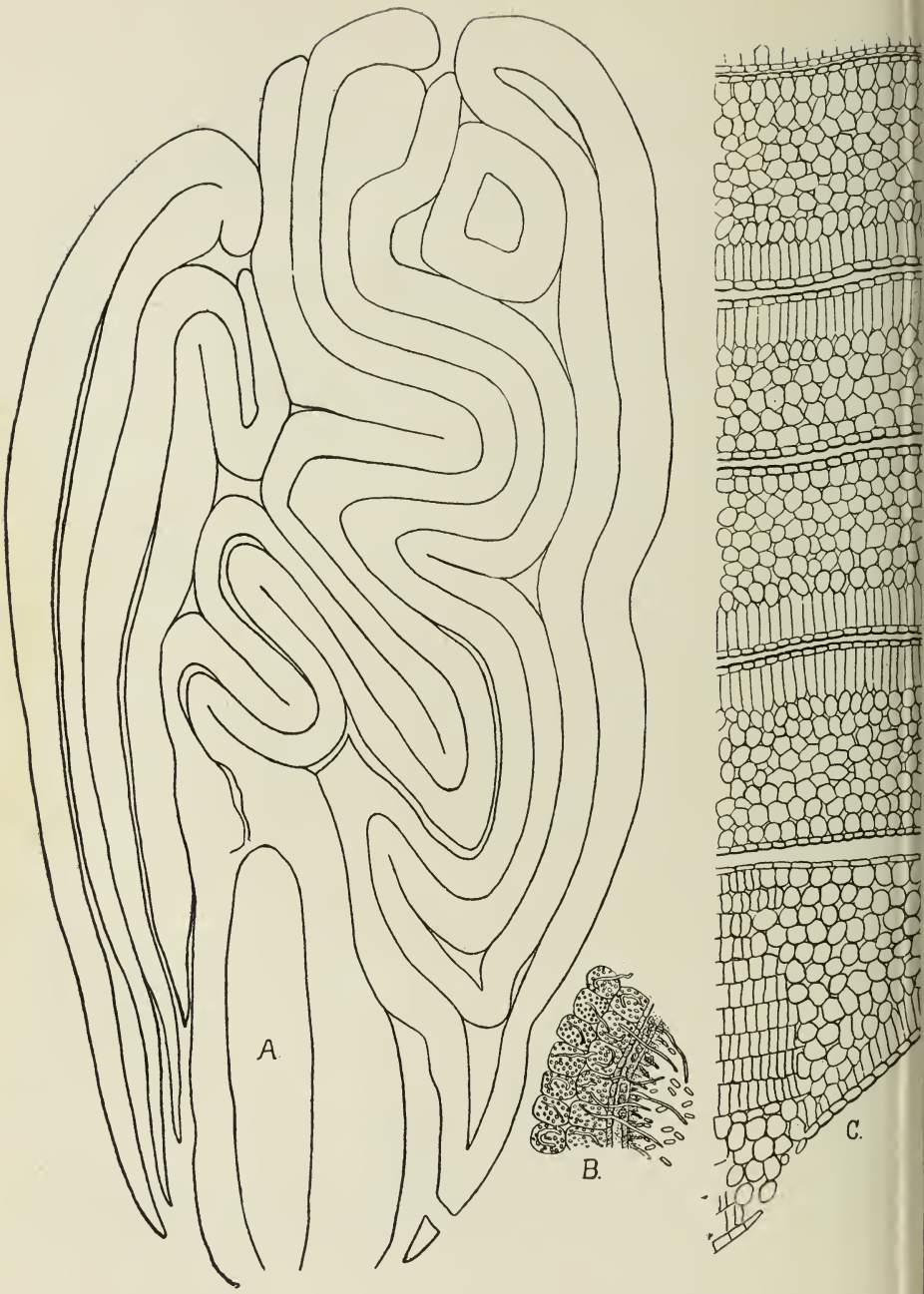

Fig. 6

A, Section of slightly diseased seed X 20. B, Part of diseased portion of A, X 300. C, Section of A, from of attachment of cotyledons to left lateral surface X 136.

scope proved to have a few anthracnose spores on the surface. Ten seed from this boll were germinated and eight of them developed anthracnose. Four others were planted in the green-

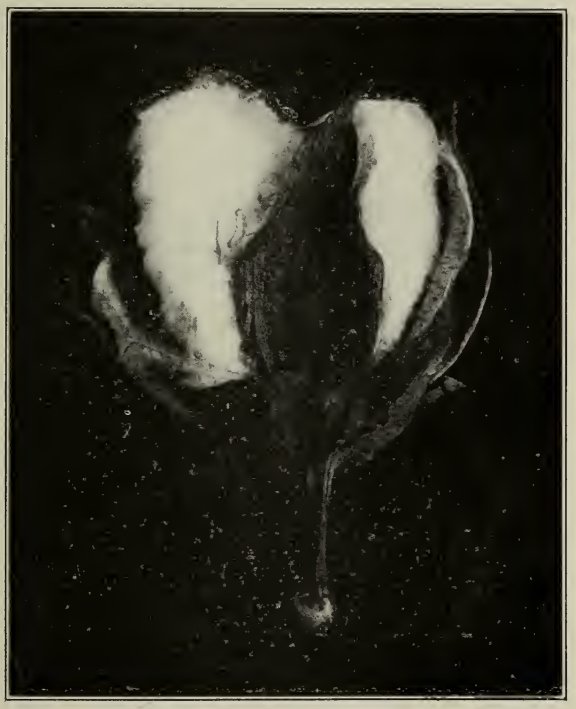

Fig. 7.
Slightly diseased boll.

house. Two of these developed anthracnose on the cotyledons, but have not yet succumbed to the disease. From the appearance of these two diseased seedlings in the greenhouse at present, it seems that this is about the kind of seed that is so effective in spreading the disease. As will be seen from the drawing of the seed sectioned from this boll, the fungus occurred on only one place inside the seed coats and here both the filaments and spores were present, Fig 6. Lint and seed were examined from two hundred and thirty bolls, which like the above, looked as though they were slightly diseased, but showed no definite diagnostic character. Anthracnose

spores were found on one hundred and eighty of these. Seed were germinated from some of these, and they invariably produced diseased seedlings. Some of them were planted in the greenhouse, and the disease is showing up on them now. Further results with such seed under various conditions and treatment will be published later.

The fungus gains entrance into the seed by going through the seed coats as is shown in Fig. 5 A. This seems to take place before the seed is mature and the coats hardened; and, where there are only a few filaments and spores inside the seed, as in the case of Fig. 6, the entrance must be made just before the hardening of the coats, otherwise the fungus would spread through the seed and destroy it. When the filaments do have time to spread through the seed, the vitality is destroyed, and the seed, although apparently healthy, will not germinate. This was shown by ten of the best looking seed, from the same lot as the one which is shown in Fig. 5, which were placed for germination. Within a few days they were covered with pink coating of spores but none of them germinated. The failure of the disease to take hold on bolls which were just opening and were sprayed with water containing spores of the fungus, seems to show that the fungus is unable to enter the seed after the boll begins to open.

Vitality of the Fungus in the Seed.

There has been some question as to how long the fungus will live in the seed and a few tests have been made with a view to determining this. Seed which were gathered in September, 1908, were germinated on October 15th, 1909, and an abundance of anthracnose appeared on the seedlings. Just about as much disease appeared on these as on the seed from the same lot when germinated ten months earlier. Individual seed were taken from several slightly diseased bolls, the seed coats removed, and the spores and some of the tissue of the cotyledons which contained filaments were placed in sterile water and hanging drop cultures. In seed of this age which were so badly diseased that the vitality of the seed had been destroyed, the spores which were taken from the surface of the endosperm failed to germinate. In all cases where such cultures were made from seed fourteen months old which were

badly diseased, neither the filaments in the interior nor the spores on the surface of the endosperms and cotyledons germinated. In other cases where the seed were not so badly diseased but were dead by this time, the filaments which were imbedded in the tissue of the interior of the seed grew and produced typical anthracnose cultures. In seed of the same age but slightly diseased, a few spores found on endosperm layer germinated; and, when the same seed were germinated, the disease showd up in abundanc, destroying the seedlings when only three to four days old. These fourteen to fifteen month old seed are the oldest available selected diseased seed that we have, so we can secure no further evidence right now as to how long the fungus will live in the living seed, but from the fact that the filaments which were imbedded in slightly diseased seed that were already dead, grew when placed in drop cultures, and from the fact that the fungus is still living in the seed which are alive, it appears that the fungus remains alive as long as the seed and in some cases a little longer. The filaments which are found in the tissue of the seed are similar to the ones found penetrating the other portions of the diseased tissue or to the ones found in young, vigorous cultures of the fungus, and not like the brown filaments observed in old cultures or in old diseased tissues. Emphasis has been placed on the thick walled, brown filaments as being able to tide the fungus over during unfavorable seasons, but my observations, so far, lead me to believe that such filaments do not ordinarily occur in slightly diseased, mature seed.

Other Evidence That the Disease is Spread by Seed.

The history of 98 per cent of the bad cases of anthracnose observed in this state during the past two seasons reveals the fact that the disease did not occur on these places until seed from some outside source were brought in. Last spring some of the general lot of seed of two of our worst diseased varieties of the previous year; viz., Columbia and Blue Ribbon, were sent out to thirty-five farmers in different sections of the state. On the 13th of last October, circular letters were sent out to each of these farmers asking for information in reference to the conditions under which these seed were planted and the amount of disease present. I have replies from twenty-two of

these and all of them have suffered more or less from anthracnose on cotton grown from these seed. The estimated losses vary in these cases from 6 to 50 per cent. Some of the seed of the Columbia variety from this general lot were sent to the sub-station at Summerville and planted on land which had never been cultivated before and which was located at least one-half mile from any other cultivated land. When examined in October, it was found that 15 per cent of this cotton was diseased. Four other definite cases of this kind came to my attention while I was visiting other localities of the state studying the disease. The five cases, then, show that the disease occurred and caused considerable loss where there was no other possible means of its having been brought there except through the seed. The same thing is evident from history of various other cases observed. A number of the worst cases in the state during the past season seemed to have come about in this way from seed houses.

Selecting Disease Free Seed.

From examinations of a large number of suspicious looking, and some apparently healthy bolls taken from the field during September past, it seemed that, by practicing sufficient care in picking, it would be possible to select from fields where the disease occurred, cotton for seed, which would be free from disease. Accordingly we went into such fields during September and October, and picked from our worst diseased varieties a quantity of cotton from bolls that had opened perfectly and gave no indication of being diseased. At the same time we picked some cotton from bolls which were evidently diseased. Seed from both of these lots have been germinated in laboratory and planted in greenhouse. An abundance of disease has showed up on those from diseased bolls, but so far no disease has occurred on a single one of those picked from healthy bolls. It seems, therefore, from this and from other knowledge which we now have, that the easiest way to get rid of the disease is to pick healthy cotton for seed. We will plant such seed next year on land that has never been in cotton and on land on which no cotton was planted this year and we hope to get no anthracnose in either case.

Significance of Fungus in the Seed.

(1) The filaments and spores of the fungus occur on the inside of mature seed. They remain alive here as long as the seed retains its vitality but will not remain alive for fourteen months in badly diseased dead seed.

(2) No treatment tried so far will injure the fungus without killing the seed.

(3) When these slightly diseased seed germinated they produced diseased seedlings which frequently grew in spite of the disease, harboring the fungus on their injured leaves, stems and leaf scars until the bolls appeared.

(4) The appearance of the slightly diseased locks, which contain mature diseased seed is such that they are picked and put in with the healthy cotton, thus the diseased seed are ginned and planted with the healthy seed. The planting of such seed is the most common method of distributing the disease.

(5) Seed selected from healthy bolls in a field where the disease is prevalent, when germinated in the laboratory, produced no disease. Since the fungus does not seem to be able to live more than one year in the soil, it seems that a one year's rotation with clean seed would eliminate the disease.

Effects of Fertilizers on the Disease.

The cotton grown in the fertilizer tests on the Experiment Station farm in the summer of 1908, was badly diseased and furnished a splendid opportunity for us to observe the influence of commercial fertilizers on the disease. These plots were fertilized with various quantities and combinations of phosphoric acid, potash, and nitrogen in different forms. Counts were made of the number of healthy and of diseased bolls on thirty-one of such plots, including several checks without fertilizers. The results indicate that the kind or amount of fertilizer had no effect on the amount of the disease. These results were published in Bulletin 145 of this Station, page 23.

The Probability of Breeding a Strain of Cotton Which Would Be Resistant to Anthracnose.

It has been noted and commented on, from time to time, that certain varieties of cotton, such as Toole, Russell Big Boll, Cleveland's Big Boll, etc. are, ordinarily, unusually free from anthracnose. Other varieties such as Columbia, Blue

Ribbon, and Cook are practically always diseased. While making observations in a field of Blue Ribbon cotton which was badly diseased in the summer of 1908, I noticed that, while the disease was very general and the majority of stalks contained one or more diseased bolls, on some stalks nearly all of the bolls were diseased and on others there was no disease at all. With the disease as general and as abundant as it was, it seemed that some of the bolls on all the stalks must have had a chance to become infected. The fact that there was such a great variation in the amount of disease on the different stalks led me to believe that some stalks might be more susceptible to the disease than others and that the ones which were free from disease might be resistant. With the view of testing this we went in the field on October 10th, 1908, and selected from the part of the field where the disease was worst eight stalks which were badly diseased and eight which were apparently free from disease. The seed from these were planted back on the same land the past season. The results are shown in Table 1.

Table 1.—Showing the results of one year's work in breeding for anthracnose resistance.

Original Stalk.				Progeny.		
No.	Disease Free Bolls	Diseased Bolls	Per Cent. of Bolls Diseased.	Disease Free Bolls	Diseased Bolls	Per Cent. of Bolls Diseased.
1	14	0	0	546	69	12.6
2	5	7	60	419	34	8.11
3	9	8	48	343	32	9.33
4	5	22	81	384	40	10.42
5	6	9	60	299	16	5.35
6	1	7	87	173	0	0
7	7	18	72	709	35	4.93
8	22	0	0	299	18	6.03
9	13	15	53	347	20	5.79
10	31	0	0	389	19	4.88
11	10	0	0	293	11	2.79
12	26	0	0	479	7	1.46
13	18	0	0	454	4	.88
14	16	0	0	506	18	3.56
15	16	0	0	433	10	2.31

As will be readily seen from the table, the highest per cent. of disease occurred in the progeny of the stalk which had no disease the previous year, and the one place where there was no disease was in the progeny of stalk which had 87 per cent. of its bolls diseased the previous year. Still the average per cent. of disease in the progeny of disease-free stalks of the previous year is 5. per cent, while the average disease in the progeny of the badly diseased stalks of the previous year is 6. 2 per cent. Thus it seems that, while the extremes such as stalks 1 and 6 would indicate that nothing can be expected from such selections, on the whole we have gained a little something. The inconsistency of these results, however, and the very small margin in favor of the progeny of the carefully selected disease-free stalks makes us doubt whether such procedure is worth while. Mr. C. A. McLendon of the Georgia Experiment Station, grew plants from some of the seed of these same original selections during the past season and his results compare fairly closely with those given above. Careful selections have been made from the most promising stalks and the same line of breeding will be continued next year. The results of these preliminary breeding experiments make me wonder whether the apparent success of DeLoach[4] and others in breeding resistant strains has not been due more to the fact that they have been selecting seed which were free from disease, thus eliminating the most important method of distribution and infection, than to any inherent resistant tendency in the plants themselves. It would be interesting to try some inoculations on such apparently resistant strains, and see what the result would be.

Resistance of Varieties as Indicated by Inoculations.

On the 25th of last August, twenty young bolls three to five days old on each of the thirty varieties of cotton then growing on the experiment farm, were inoculated by spraying with water containing spores from pure culture. The weather was exceedingly dry and hot immediately after these inoculations were made, and as this caused the cotton to shed exten-

4.—Georgia Experiment Sta. Bulletin No. 85.

sively, a large number of these inoculated bolls were lost in the shedding. So few of them remained, and the number remaining varied so on different varieties, that it seems as though the results of the inoculations are hardly worth giving. Of the inoculated bolls that did hold on, however, some of every variety produced disease. While there were not enough bolls left to form any idea as to the comparative resistance, the fact is established that even under these unfavorable conditions, no variety was totally resistant or immune. It is hoped that this experiment can be repeated on a larger scale and under more favorable conditions next summer.

Conclusions.

When the fungus comes in contact with healthy, vigorous bolls under, favorable conditions, it is able, of its own accord, to enter and cause disease.

The fungus enters the healthy seed when they are nearly mature and after seed are mature remains there in resting condition until the seed germinate. It then produces disease on resulting seedlings.

Chemical treatment has no effect on such seed.

By picking cotton from carefully selected, healthy bolls, seed which are free from disease can be secured, even from badly diseased fields.

The fungus seems to be unable to live more than ten months on the old diseased bolls and seed in the field.

It seems, therefore, from the data at hand, that a one year's rotation with clean seed ought to eliminate cotton anthracnose.

* * * * * *

Special thanks are due to the following for assistance in carrying out the work outlined here:—Mr. G. W. Keitt for valuable and continuous assistance in making inoculations, cultures, doing histological work and assisting with the drawings; Prof. J. N. Harper and Prof. George G. Ainslie for valuable assistance and suggestions in making the photographs.

H. W. BARRE.
Botanist.

Fall and Winter Cabbages.

While cabbages are grown in almost every garden in the South as a spring crop, few of us appreciate their value as a

fall and winter vegetable. As the plants for the winter crop are not set to the field until after the 15th of July they may follow a crop of onions, potatoes or any of the early crops which may be harvested in time to allow a thorough preparation of the soil before time for planting.

Preparation of Soil.

Plow the land from 6 to 12 inches deep according to the depth of the soil and harrow immediately to pulverize the clods and to smooth the suface. If the soil contains an abundance of humus a good crop of cabbage may be grown without the use of barnyard manure provided a liberal application of complete fertilizer is made. However, the crop will be greatly benefited by the use of from 8 to 12 tons of well decomposed manure in addition to the commercial fertilizer. If there are only a few tons of manure available it is best to apply in the drill with the fertilizer. Otherwise, it should be applied broadcast before plowing. The rows are marked off three feet wide and a trench opened by running two furrows with a Dixie or half shovel plow. The manure and fertilizer is distributed along the row and mixed by running one furrow with a plow.

The Plant Bed.

For winter cabbages the seed should be planted about the first of June. They may be sown in the field or frame, and after the plants are well established they should be thinned out to one inch apart in the row in order that they may become stocky. Keep the plants free from grass and weeds but do not encourage them to grow too rapidly while in the plant bed. The plants are set to the field between July 15th and August 15th. It is, therefore, necessary for them to be stocky and tough in order that they may be able to withstand the hot and dry weather of late summer. If the seed are sown in a spent hotbed or frame where the conditions may be controlled, the plants may be checked in their growth as may be necessary. Two weeks before the plants are set to the field they should be hardened off. This is done by allowing the bed to become moderately dry which checks the growth and causes them to become hard and tough. This enables the plants to better endure the transplanting and insures a good stand. If the

plants are in tender growing condition when transplated, a large per cent. of them will die regardless of how carefully they have been transplanted. If they are first transplanted to two inch pots three weeks before they are set to the field practically all of them will live. The potting is very easily and rapidly done. One man with a little practice can pot two hundred in an hour. The pots should be filled with soil to within one-half inch of the top. If the pots are full of soil the water will run off when the plants are sprinkled instead of soaking into the soil in the pots. After potting the plants plunge the pots to the rim in soil or sand. This will prevent them from drying out so rapidly and will, therefore, require less attention.

Transplanting to the Field.

The plant bed should be watered thoroughly before removing the plants in order that they may be taken up with as many roots as possible. Special care must be taken to keep the plants moist and protected from the sun and wind until transplanted. They are set in the open furrow after mixing the manure and fertilizer as described above. The large growing varieties are set three feet apart in the row and the small early varieties need not be set farther than two feet. In setting the plants a small hole is made in the furrow with a hoe. The water is then poured in and the plants set immediately, leaving the bud on a level with the surface of the soil. The plants should always be set as deep in the soil as the leaves will allow and a loose mulch of dry soil should be left on the surface around each plant. If the plants are rather large when taken from the plant bed, a few of the outside leaves should be removed before transplanting.

Fertilizers.

On land that will produce one bale of cotton per acre, 1000 lbs. of fertilizer analyzing 8 per cent phosphoric acid, 4 per cent. nitrogen and 7 per cent potash should be applied in the drill and thoroughly mixed before the plants are set. If the soil is lacking in humus from 20 to 30 tons of barnyard

Fig. 1.
Two heads of Succession cabbage cut from the field December 15th, after having withstood a temperature of 26 degrees.

manure should be applied before preparing the land. If cabbages are to be grown on comparatively poor land and there are only a few tons of manure available, it is best to apply in the drill and mix with the commercial fertilizer. After the plants have become well under way, before they begin to head, an application of 200 lbs. of nitrate of soda will give excellent results. This should be sown broadcast between the rows and then mixed with the soil. If we are to grow profitable crops of cabbage we must ever have in mind that thorough preparation, good cultivation and high fertilization are necessary for best results.

Cultivation.

Cabbage should be cultivated after every rain to prevent the formation of a crust on the soil and to maintain the soil mulch which prevents the rapid evaporation of moisture from the soil. A spring tooth cultivator is an excellent tool for this purpose.

Varieties.

Contrary to the general opinion, the early maturing varieties are better suited for winter use in the South than the late varieties. If the late varieties are planted at the usual time in the spring they will mature before fall, and if planted in late summer they will not mature until midwinter and are liable to be seriously injured before they are ready to be harvested. In the mountain section where the summers are not too severe the late varieties set out in May and June mature during the months of October and November.

We have tested practically all the varieties of cabbages in our trial grounds for the last five years and the Charleston Wakefield, Early Summer and Succession have given best results for fall and winter use, when planted to the field the first week in August. There are of course a large number of varieties that will produce fine fall cabbages, but the three mentioned seem to be about the best for this section of the country. The two first named varieties will mature during October and November, and the Succession will form large solid heads by the middle of December. The late Drumhead Savoy will probably endure more cold after heading than all

of the smooth leafed varieties and is therefore very desirable for a very late winter cabbage.

Fig. 2.

Drumhead Savoy cabbage cut from the field January 15th, after having withstood a temperature of 20 degrees.

Few of us appreciate how much cold the cabbage is capable of enduring without injury. In our trial grounds here little damage has been done when the temperature dropped as low as 26 degrees. About 50 per cent of the heads were injured when the temperature dropped to 18 degrees.

Figure 1 shows two heads of Succession cabbage cut the

15th of December after having withstood a temperature of 26 degrees.

Figure 2 shows a head of Drumhead Savoy cut January 15th after having stood a temperature of 20 degrees.

A bulletin is now being prepared on this subject which will be ready for publication in the early spring.

C. C. NEWMAN.
Horticulturist.

PEACH TREE BORER.

(*Sanninoidea exitiosa*)

A. F. Conradi and W. A. Thomas.

Among the insects attacking the body of the tree, the peach tree borer is the most important next to San Jose Scale. As this insect has only one generation each year to combat it intelligently by improved methods, it is essential to know the period of pupation. A full discussion of this subject is found in Bulletin 143 issued in March, 1909. These observations are applicable to the latitude of Clemson, our investigations having been confined to the vicinity of the S. C. Experiment Station. For the season of 1908 the accompanying diagram illustrates the pupation period under the climatological conditions as given.

Mr. W. A. Thomas was in charge of the details of this investigation. The life history work in the laboratory was regarded secondary and merely served as a check on some phases of the work outdoors. The pupation and emergence were observed in the field at the base of the tree from May 27th throughout the season in order to obtain the correct data for orchard conditions. On June 16th larvae measuring from 3-4 to 7-8 in. in length were removed from the trees. On June 25th it was noticed that ropy strings of castings were protruding from the burrows. On July 1st, the first pupae were found. The larvae in the trees were very active as was noticed by the castings and pupation continued until July 10th, when all activity ceased, probably owing to the wet condition of the soil; on July 2nd activity was resumed.

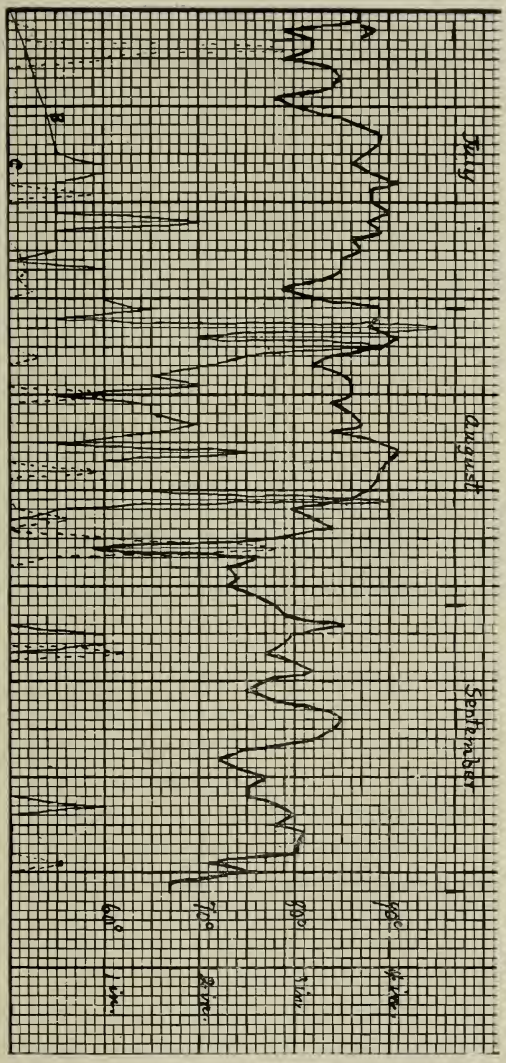

Fig. 1.

Pupation of peach tree borer. (S. exitiosa) A, temperature. B, pupation. C, rainfall. (original)

On August 1st, an orchard about one mile east of the Experiment Station was examined where thirty-five pupae, twenty-five empty cocoons and two larvae about ready to pupate were found. It was noticed that near one tree a larva had crawled

at least six inches from the base of the tree and pupated directly under a piece of iron lying on the ground. The soil at the base of two trees was thoroughly ramified by the tunnels of moles and although the trees showed heavy gum exudations, no pupae were found. Examination of these trees on August 15th showed thirty-nine pupae and two full-grown larvae.

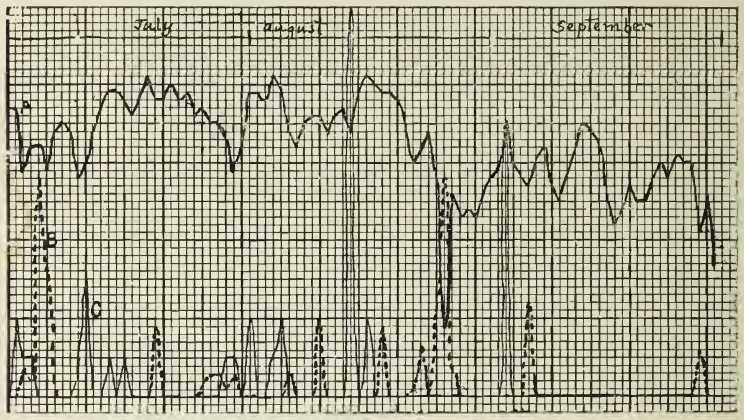

Fig. 2.

Pupation of peach tree borer. (S. exitiosa) A, temperature. B, pupation. C, rainfall. (original)

On August 23rd, Mr. Thomas examined heavily infested peach trees at Marlboro, S. C. The adults were rapidly emerging. Several cocoons were collected and within about five minutes three adults had emerged. Several adults were seen resting on weeds near the infestd trees. On September 2nd, adults were emerging rapidly near the Station. On September 16th, an examination of the orchard near the Station gave four pupae, but no larvae except those of the new generation which had bored into the bark and were about 2 to 4 mm. long.

Summarizing, all the data gathered gave the following result for the season 1908 at this Station and vicinity. Pupation began July 1st, gradually increasing until the maximum was reached August 2nd. Then there was a gradual decrease until approximately Sept. 2nd, a few stragglers pupating as late as September 16th.

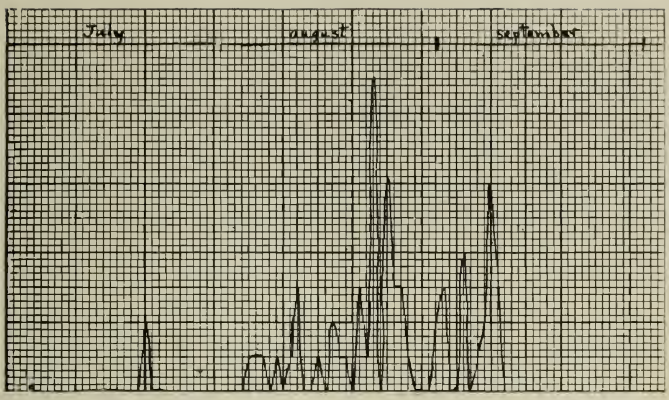

Fig. 3

Emergence of peach tree borer. (S. exitiosa) (original)

The adults began to emerge July 20, increasing until the maximum was reached August 22nd. There was a continual decrease until September 20th, after which only stragglers were seen. Wrappings and moundings should be in position from July 10th to October 1st. These mounds are in position during the egg laying season of the adult females, the eggs being deposited at or near the surface of the soil. Where these mounds are taken down it will leave the eggs and young larvae some distance above the crown where they can be more easily located and their removal greatly facilitated. The worming done by this method is also more thorough than by the old way of digging them out of the trunk below the surface of the soil.

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HON. B. H. RAWL.

J. N. HOOK, *Secretary.*

W. M. RIGGS, *Acting President.*

EXPERIMENT STATION STAFF.

J. N. HARPER, B., S., M. AGR., *Director Agriculture.*

C. C. NEWMAN, *Horticulture.*

H. W. BARRE, B. S., *Botany and Bacteriology.*

A. F. CONRADI, B. AGR., M. S. *Entomology and Zoology.*

THOS. E. KEITT, B. S., *Chemistry.*

E. BARNETT, V. M. D., *Animal Husbandry and Veterinary Science.*

JOHN N. HOOK, *Secretary and Librarian.*

W. D. GARRISON, B. S., *Superintendent Coast Experiment Station.*

BURNS GILLISON, *Foreman of Station Farm.*

MISS HELEN BRADFORD, *Stenographer.*

Mail and Telegraph: Clemson, S. C.

Freight and express: Calhoun, S. C.

The bulletins of the Station are issued at irregular intervals, and are sent free to all citizens of the State who apply for them.

LETTERS OF TRANSMITTAL.

Clemson College, S. C., Dec. 1, 1910.

Hon Alan Johnstone, Pres. Board of Trustees, The Clemson College Agricultural College.

Dear Sir: I beg to submit herewith the twenty-third Annual Report of the South Carolina Agricultural Experiment Station, which in accordance with the law, must be submitted to the Governor on or before Feb. 1st., 1911.

Yours very truly,

W. M. RIGGS,

Acting President.

Clemson College, S. C., Dec. 1st, 1910.

Hon. M. F. Ansel, Governor of South Carolina,

Sir: I have the honor to submit herewith the Twenty-third Annual Report of the South Carolina Experiment Station, in accordance with the requirements of an Act of Congress, approved March 2, 1887, for the establishment of Agricultural Experiment Stations in connection with the colleges of the several States, organized under the provisions of an Act approved July 2, 1862.

Respectfully submitted,

ALAN JOHNSTONE.

President, Board of Trustees.

ANNUAL REPORT OF DIRECTOR OF SOUTH CAROLINA EXPERIMENT STATION.

Clemson College, S. C., July 5, 1910.

Prof. W. M. Riggs, Acting President, Clemson College.

Dear Sir: I have the honor of submitting herewith the twenty-third annual report of the South Carolina Experiment Station for the fiscal year ending June 30, 1910.

A greater amount of work has been accomplished by the Station during this past fiscal year than during any previous year of its history. A number of new facts have been discovered, and the work of the Station is receiving recognition not only in this State but also in other States. The members of the Station Staff have been untiring in their efforts to solve some of the fundamental problems on which they are engaged, the solution of which will be of great practical value to the farmers, stockmen and horticulturists of this and adjoining States. Every man has done his best to make the work of the Station a success, and most cordial relations have existed between this department and all other departments of the College.

Most of the experiments now underway are a continuation of those planned a few years ago. Some few have been brought to an end and new phases of the problems have been evolved.

As heretofore, the correspondence of the Station officers with the farmers of the State has amounted to several thousand letters. In most of these letters the farmers are seeking detailed information and this information is of such a nature that only the experimenters can give it. All letters of a general nature and those that can be answered by some one possessing general information, we believe should be referred to the Extension Division when that division has been developed so that it can handle them.

During the year most of the members of the Station Staff

assisted the Extension Division of the College in conducting farmers' institutes in different parts of the State. This work has been very beneficial to the experimenters for it gave them an opportunity to come in personal contact with the farmers and to learn their needs, thus placing the experimenters in a better position to know which problems need their attention most.

The Station, in co-operation with the College, made an elaborate exhibit at the State Fair last autumn. The exhibit of the Station was of such a character that the farmers of the State, by viewing it, could comprehend the scope of its work. The Director of the Station was re-elected to membership on the Executive Committee of the State Fair Association and placed in charge of one of the departments of the State Fair.

The members of the Station Staff have always taken an active interest in the work and meetings of the various associations and societies in the State, the object of which is to promote progressive agriculture. One of the most important of these associations is the S. C. Live Stock Association and its annual meeting was attended by the majority of the Station Staff and they took an active interest in all of its proceedings. The Director was one of the promoters and founders of the State Corn Breeders' Association and also the State Cotton Breeders' Association.

The Station continues to co-operate with the U. S. Department of Agriculture in an experimental way. The Agricultural Division is co-operating with the Bureau of Plant Industry in testing a number of forage plants, the seed of which are from various states and from different countries. This division is olso co-operating with the Division of Farm Management. During the year, the Station sent out under Government frank, a great number of samples of burclover seed to various farmers who were growing winter cover crops under the direction of Mr. A. G. Smith.

The Division of Entomology is co-operating with the Bureau of Entomology,—Division of Southern Field Crop Insects,—on the investigation of the root louse and wire worm affecting corn and cotton.

The Division of Botany continues to co-operate with the

Bureau of Plant Industry in making a plant disease survey of the State.

The Division of Veterinary Science and Animal Husbandry continues to co-operate with the Bureau of Animal Industry in its work with the hog cholera serum.

During the past year, we have met all the requirements of the Office of Experiment Stations in the restriction it has placed around the Hatch and Adams funds. Recently, the Director of the Office of Experiment Stations visited this Station and went over carefully its accounts and all experiments under investigation. He gave his approval to all work now under way and the methods of prosecuting the experimental work.

During the year we have added quite a number of books to our library, and we have now the most complete set of Government and State bulletins probably in the country.

Our Experiment Station farm is being greatly improved, and with the recent purchase of the thre grade Percheron mares we have sufficient work stock to do all of the work necessary.

The last session of the Legislature passed a pure seed law, the analytical work of which was imposed upon the Experiment Station. The enforcement of this law was placed in the hands of the State Commissioner of Agriculture. The Director of the Station has made satisfactory arrangements with the Commissioner of Agriculture for the carrying out and the enforcement of this law. The analytical work of the seed inspection is under the direction of the botanist of the Station. The salary of the analyst and all expenses of the analytical work are paid by the Commissioner of Agriculture.

Below is given a summary of the different experiments now underway by the different divisions.

Agricuitural Division.

1. Experiments to determine the fertilizer requirements of the upland soils of South Carolina for the various staple crops and the proportions of phosphoric acid, potash and ammonia that make up these fertilizers for these different crops when grown in five different crop rotations. These experi-

ments are an enlargement of those that have been in progress for five years. The results of three years of the work have been published in Bulletin No. 145.

2. Experiments to determine the best paying system of crop rotation with a view of keeping up the fertility of the soil, cotton being one of the main crops in the rotation. These rotations cover periods of two, three and five years.

3. Experiments to determine the best variety of cotton suited to the different soil types of the State. In this experiment we are co-operating with quite a number of farmers living in different sections of the State. We are sending out two and three varieties of cotton to a great number of farmers who are co-operating with us. More interest is being shown in this co-operative experimental work than in any other feature of our undertaking, and while this cannot be in any sense considered strictly research work, nevertheless data will be obtained that will be of great practical value to the farmers.

4. The breeding of cotton with the view of increasing the yield, length and quality of the fiber, increasing the size of the boll and general vigor of the plant. Results of three years' work on this experiment were published in Bulletin No. 148. We have several varieties of cotton that have been developed at our Experiment Station that are most promising indeed.

5. The breeding of corn with the view of increasing the size and uniformity of the ear and increasing the yield of the grain, also to obtain a low growing, thick, strong stalk. We are conducting these experiments according to the method developed by Mr. Kyle of the U. S. Department of Agriculture.

We are also making a number of crosses between the prolific and gourd seed varieties of corn with the object in view of obtaining a prolific variety with deep kernels.

6. Experiments to determine the relative value of nitrate of soda, sulphate of ammonia and cotton seed meal as a source of ammonia for cotton, corn, oats and wheat.

7. Continuation of experiments to determine the best time to apply nitrate of soda as a top dressing to corn, cotton and oats. From our experiments heretofore we have obtained data that show that nitrate of soda should be applied to oats in the very early spring, about February 15th, and to cotton about

the time the first bloom appears, and to corn when about shoulder high. When applied as late as when the first tassel appears, it apparently does nothing more than to cause the corn to change to a deeper green, but it does not, according to the weights of the harvested corn, increase the yield.

8. Experiments on the application of commercial fertilizers to corn at different periods of its growth.

9. A continuation of the testing of various forage crops and cereals, such as German millet, oats, wheat, rye, barley, sorghum, red clover, bur clover, timothy, soy beans, crimson clover, vetch, cowpeas and beggar weed. We have obtained large yields of German millet when grown after bur clover. We have also been successful in producing a large amount of timothy when grown after crimson clover that followed vetch and oats.

10. Continuation of experiments to determine the best time to apply phosphoric acid and potash to oats. From our experiments thus far, we are led to believe that it pays to apply in the spring acid phosphate and potash in addition to that applied at the time the oats were planted in the autumn.

11. Continuation of the variety test of wheat, corn, alfalfa, cowpeas and sweet potatoes.

In our wheat variety test; we have gotten the best results from the Red May wheat from southern Alabama and Georgia. The northern grown varieties do not give the yield that the southern grown varieties do. In this work we have obtained a great number of varieties from the Kentucky Experiment Station and three varieties from the Alabama Experiment Station.

We have completed our test of varieties of alfalfa. In this experiment we found that most of the failures experienced by alfalfa growers have been due to the fact that the seed were obtained from the southern part of the country and that the growers failed to apply large amounts of lime to their soil.

The object of the variety work with sweet potatoes has been to obtain a higher and a variety valuable for starch production. One more year will give us sufficient data to justify our discontinuing this experiment.

12. Experiment to determine the best legume to plant in

cotton as a winter cover crop, bur clover, vetch, rye and crimson clover being the crops used. This is used in the two crop rotation where corn follows cotton, followed by corn.

13. Experiments to determine the best grass to be used in holding terrace banks. Thus far, we have found that Texas blue grass, Perennial rye grass, Italian rye grass, Bermuda grass, green all during winter, thus catching the soil as it washes down from above, and it does not spread like the Bermuda does. In this work we are using Texas blue-grass, Kentucky blue grass, Perennial rye grass, Italian rye grass, Bermuda grass, Para grass, alfalfa orchard grass and bur clover.

14. Experiments to determine the best form in which to apply phosphoric acid to our type of soils. In this experiment we are comparing the relative value of ground phosphate rock with acid phosphate and thomas phosphate.

15. Notes on the cross breeding of horses, the German Coach and the Standard Bred horses being the types used.

Horticultural Division.

Peaches.

A study of the effect of frost on different elevations and exposures.

Variety test.

Apples.

Variety test.

Experiments in breeding new varieties.

Persimmons.

Test of Japanese varieties.

Selecting, propagating and breeding native varieties.

Pears.

Effect of different methods of culture on pear blight.

Variety test.

Grapes.

Variety test.

Breeding new varieties.

Rotundifolia Grapes.

Variety test.

Pruning experiments.

Methods of training on trellis and arbor.

Experiments to determine the lack of close fertilization and to determine the cause of self sterility.

Blackberries, Raspberries and Strawberries.

Variety test of the newer varieties.

Asparagus.

Breeding experiments with an idea to develop a variety immune to asparagus rust.

No experiments have been conducted with truck crops this season on account of the change of the location of the horticultural grounds. A large amount of work during the last year has been devoted to the improvement preparatory to experimental work.

Botanical Division.

The botanist and plant pathologist continues his study of the life history of the fungus which causes anthracnose of cotton. During the past year he has obtained some valuable results from his experiments on this disease. He has discovered a number of new facts, the most important of which is that this fungus is carried entirely in the seed. During the course of his investigation, he has found that the fungus does not seem to be able to live for more than ten months on old diseased bolls and seed in the field; that the fungus is able of its own accord to enter healthy bolls and cause disease; that the fungus seem to thrive especially well on the seed,—destroying the seed of badly diseased bolls and entering the seed of slightly diseased bolls, remaining dormant there in the mature seed and causing disease on the resulting seedlings and that chemical treatment has no effect on such seed.

This season this division is conducting experiments with the view of determining whether or not (1) it is practical to secure disease-free seed for planting from a field in which the cotton is badly diseased; (2) how and where the fungus lives on the plants from the seedling stage until the bolls appear; (3) to what extent the disease spreads from one plant to another; (4) and what the agents of distribution are. This division is growing cotton from seed which there is every reason to believe were free from disease and is continuing the breeding work with the view of finding whether or not it is

possible to breed a variety of cotton which would be immune to the disease.

The work on sweet potato rots and on the plant disease survey is being continued along the same lines as heretofore.

Division of Entomology and Zoology.

The lines of work in progress in the Division of Entomology and Zoology are as follows:

1. The investigation of the injurious nematoid worms of the digestive tract of calves and sheep (in co-operation with the Division of Veterinary Science.)
2. The relation of temperature to insect activity.
3. Co-operative field work.
4. Miscellaneous investigations.
5. Inspection and insect quarantine.

Although a number of important points were worked out during the past year in connection with the hook worm and stomach investigation and the report of progress made in the twenty-second annual report, the investigation is continued owing to the complications on account of several other parasites present, so that the direct cause of the death among sheep and cattle is not yet determined to the satisfaction of the divisons concerned.

The chief purpose of the temperature work is the accurate and detailed study of the life history and habits of injurious insects. There are undoubtedly certain laws that govern insect activity about which we know nothing and not until we learn the role which temperature, moisture and heredity play in the development of insects can we hope to put economic entomology in this State on a rational basis.

The number of generations is all important in insect control. Do these vary or are they constant? The former is environment; the latter, heredity. What are the laws of variation or constancy? When we know these, then we can give advice at any season of the year with almost absolute accuracy.

The co-operative field work has developed substantially and is becoming of far reaching importance. Although the State was covered as thoroughly as possible, the principal efforts are now directed against the cotton and corn root louse, with

headquarters at Marion; and the cotton and corn wire-worm, with headquarters near Getsinger in Colleton County.

Co-operative work is carried on against the plum curculio and brown rot of peach. This work is carried on co-operatively between the Divisions of Botany and Entomology.

The corn bill bugs, as well as the Southern corn root worm and the red spider of cotton, are pests that should be investigated. The cotton root louse and wire-worm investigations are carried on in co-operation with the Bureau of Entomology of the U. S. Department of Agriculture, and Mr. W. A. Thomas is in direct charge of the field laboratories.

There has been an active correspondence in this division during the past season.

The inspection work during the past season was in charge of this division. The nurseries of the State were inspected, and a large amount of State work was also done. The State work consisted principally of insect quarantine and of miscellaneous assistance in various sections.

Chemical Division.

The work of the Division of Chemistry has been largely devoted to the following experiments:

1. Experiments to determine the relative availibility of the animal sources of nitrogen compared with nitrate of soda as a standard. The analytical part of this work has been completed. Pot tests are being continued. During the past year two series of pot tests have been run. The crops used were corn and oats.

2. Experiments to determine relative value of basic slag as compared with acid phosphate, and to determine methods for making the determination of the availibility of phosphorus in slag to devise methods for determining the total phosphoric acid in slag.

3. The continuation of the sweet potato investigation. The work for the past year on this problem has consisted of the preparation of twenty samples for analysis.

The work on the Adams fund projects has consisted of the designing of the extraction apparatus. This apparatus has been made and is now installed in the laboratory.

This division has also co-operated with the Division of Entomology in the field work in the wire worm investigation. The entomologist of the Station called upon the chemist to aid him in this investigation by suggesting formulas for fertilizing the experimental plots and by making the mixtures and applying them. This work was done last March. In planning the fertilizer schemes for this experiment, the chemist has as fully as possible run the per cent. of acid phosphate with basic slag.

The chemist has further conducted experiments to determine the cause of the non-gorwth of peas in certain sections of the State. He has inaugaurated carefully planned experiments on the farm of Mr. Lewis S. Lucas of Pinopolis, S. C. to determine the cause of the non-growth of peas, the three possible causes, acidity of the soil, lack of inoculation and wilt being taken into consideration.

The chemist has co-operated with the Association of Official Agricultural Chemists as a referee on soils in the study of the magnesium nitrate method for the determination of the phosphorous contents of soils.

In addition to this experimental work, the laboratory work has consisted of the following: 15 complete analysis of fertilizers, 13 analysis of feed stuffs, 6 miscellaneous analysis of phosphate rock, swamp muck, etc., a complete analysis of soils from the Gonzales farm consisting of 23 samples, complete analysis of soil of blackjack land, top and subsoil; complete analysis of soil of coastal plain, top and subsoil; partial analysis of freshly drained bottom land; and 7 acidity determinations. Aside from this, he has made a number of analysis to determine the quality of Paris green that is being offered and sold in the State. He has also made a number of analysis of home mixtures of commercial fertilizers as made under farm conditions.

Division of Animal Husbandry and Veterinary Science.

The work done by this division during the past year has been largely a continuance of the previous year's work.

The experiment in feeding cotton seed meal to dairy cows has been continued with the result that the previous findings

have been verified, but as this work has taken on a new phase, in co-operation with the Division of Chemistry, that of studying the toxic effect of feeding various extracts of cotton seed meal, it has been thought advisable to refrain from publishing until results are obtained from this phase of the work.

The experiments with hog cholera serum in co-operation with the Department of Agriculture have been continued with gratifying results, leaving no doubt as to the efficiency of the serum in outbreaks of hog cholera, the results of the work being embodied in Bulletin No. 152. It is confidently expected that this method will find a wide field for application throughout the State, and, properly provided for, will prove to be a great incentive to hog raising.

The work in connection with the Division of Zoology on stomach and hook worms has been continued, though lack of infested material has somewhat hampered the work. Further evidence has, however, been obtained showing that the most rational method is that of freeing pastures rather than attempting to treat animals already sick, this being true for the sheep introduced to the Station pastures as well as for the young cattle on the College farm. This season has, however, been a very favorable one for the development of these parasites and we are awaiting with interest developments in the early fall.

With a view to finding a cheaper source of carbohydrates than corn meal for dairy cattle, an experiment has been conducted from November last with dried beet pulp. Though this is not quite completed, present indications are that for use along with cotton seed meal, and at the present relative prices, the dried beet pulp is more profitable as a dairy feed than is corn meal. Further experiments will, however, be conducted along this line before publishing results.

In the breeding of high class Berkshire hogs, this division, I believe, is doing a work that is much appreciated by the farmer, and it has been fortunate in securing, what is considered by impartial judges, the best Berkshire boar in the South from which we are expecting great things.

A feature of the work this division is paying much attention to is that of showing the superiority of heavy feeding over

light feeding for the production of milk even at the present high prices of feed, and there are now many examples in the herd which go to prove this conclusively.

The general health of the herd could not be better than at present, with a few exceptions due to excessive feeding of cotton seed meal experimentally.

In conclusion, I would like to state that this has been a most successful year for the Station and all of our relationships with the U. S. Department of Agriculture, the State Agriculture Department, and the divisions of the College have been most pleasant and profitable.

I wish to express to you my thanks and appreciation for the interest you have shown in our experimental work and for the assistance you have given us by suggestions and otherwise.

I beg to remain

Very truly yours,

J. N. HARPER,
Director.

SOUTH CAROLINA AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH THE UNITED STATES APPROPRIATIONS, 1909-1910.

Debtor		Hatch Fund.	Adams Fund.
To receipts from the Treasurer of the United States, as per appropriations for fiscal year ended June 30, 1910, under acts of Congress approved March 2, 1887 (Hatch Fund), and March 16, 1906 (Adams Fund)		$15,000.00	$13,000.00
Credit.	Abstract.		
By Salaries	1	8,375.00	7,175.00
Labor	2	2,139.57	2,889.66
Publications	3	1,031.51	
Postage and stationery	4	142.70	142.84
Freight and express	5	197.57	111.52
Heat, light, water, and power	6	53.32	51.58
Chemical supplies	7	145.22	261.23
Seeds, plants, and sundry supplies	8	385.23	410.52
Fertilizers	9	446.32	245.52
Feeding stuffs	10	831.30	901.96
Library	11	93.51	14.75
Tools, implements, and machinery	12	285.26	311.76

Furniture and fixtures 13	213.76	
Scientific apparatus 14		158.81
Live stock 14	121.00	82.78
Traveling expenses 16	109.25	98.70
Contingent expenses 17	15.00	21.70
Buildings and land 18	414.48	121.67
Total	$15,000.00	$13,000.00

We, the undersigned, duly appointed Auditors of the Corporation, do hereby certify that we have examined the books and accounts of the Treasurer, South Carolina Agricultural Exjeriment Station for the fiscal year ended June 30, 1910; that we have found the same well kept and classified as above; that the receipt for the year from the Treasurer of the United States are shown to have been $15,000.00 under the act of Congress of March 2, 1887, and $13,000.00 under the act of Congress of March 16, 1906, and the corresponding disbursements $15,000.00 and $13,000.00; for all of which proper vouchers are on file and have been by us examined and found corect, thus leaving balances of $..... and $.....

And we further certify that the expenditures have been solely for the purposes set forth in the acts of Congress approved March 2, 1887, and March 16, 1906, and in accordance with the terms of said acts, respectively.

(Signed) R. W. Simpson,
Chairman, Finance Committee, Auditors.

Attest: P. H. E. Sloan, Custodian. ffl

South Carolina Agricultural Experiment Station,
1909-1910.

(Supplementary Statement).

This supplementary statement, while not required by law, is desired as an aid in interpreting the account tendered for the United States appropriation. While it will be more useful if made in conformity with the schedule fixed for that appropriation, if this is not practicable such a summary of receipt and expenditures from the sources indicated below as can be conveniently prepared from the books of the station may be substituted. Whenever practicable, it should be for the fiscal year ended June 30.)

Debtor

To balance on hand July 1, 1909	$3,209.01	
Receipts from other sources than the United States for the year ended June 30, 1909	5,400.52	
Total		$5,077.18

Credit.

By Salaries		
Labor	$ 40.75	
Publications	901.70	
Postage and stationery	23.92	
Freight and express	218.84	
Heat, light, water and power	31.85	
Chemical supplies	39.58	
Seeds, plants, and sundry supplies	181.91	
Fertilizers	168.20	
Feeding stuffs	9.06	
Library	156.95	
Tools, implements and machinery	120.20	
Furniture and fixtures	80.63	
Scientific apparatus	5.00	
Live stock	2,299.93	
Traveling expenses	177.24	
Contingent expenses	55.43	
Buildings and land	106.30	$4,617.49
		$3,992.04

REPORT OF HORTICULTURIST.

Clemson College, S. C., Oct. 14, 1910.

Prof. J. N. Harper, Director, S. C. Agricultural Experiment Station.

Dear Sir: I herewith submit the annual report of the Horticultural Division of S. C., Experiment Station for the year ending June 30, 1910.

The work of the Horticultural Division has necessarily been largely preparatory for future experimental work, owing to the fact that the greater portion of the land assigned to this division was in original forest two years ago. Practically all of the stumps have been removed with a stump puller and the land thoroughly plowed and subsoiled. A crop of peas and crimson clover was grown on this land last season. This was turned under and the land again seeded to cover crops. Peas will be turned under during the coming fall and the land again seeded to clover and other cover crops.

Pear Orchard.—The block of trees set for the purpose of conducting experiments in combating pear blight is doing nicely. The trees have made two years' growth and as yet have not blighted. Beginning with this fall, the cultural method of each plot will be different.

Apple Orchard.—The young apple orchard set two years ago is progressing nicely. These trees are of uniform shape and size and have made unusually good growth during the past season. The Black Winesap, which is one of the very best

seedling apples, fruited for the first time the last season and the present indications are that this will be one of the very best commercial apples for the Piedmont region. The fruit is very large and showy and the trees are vigorous and healthy. It ripens about the middle of October and keeps well in ordinary storage until the last of January. The other seedling apples which we have collected from time to time, have not yet fruited. Trees, however, are in good condition.

Peach Orchard.—The peach orchard set two years ago is in a vigorous growing condiiton and has set a heavy crop of bloom buds, and from present indications, we will have a good

crop of peaches from these trees next season. This orchard is located on one of the highest points on the College grounds and we believe the fruit will not be injured by frost. This fall an orchard will be set on the east side of the same hill and about one hundred feet lower, and another one on the west side at about the same elevation. This is to see what effect the elevation and exposure will have on saving fruit from frost.

The Japanese and native persimmons are doing well. We have gathered from the fields in Oconee, Anderson and Pickens counties a great many very promising seedling persimmons. These have been propagated and are now growing in the orchard. They ripen from the first of September to the first of December. These varieties should prove to be very valuable, especially for hogs. The quality, however is very good, and if they could be placed on the market in good condition there would no doubt be a ready sale for them.

The Grape Vineyard.—The bunch grapes fruited for the first time this season. There are about 125 varieties in all, but so far they have not fruited sufficiently to draw any conclusion as to their merits. This vineyard consists of the standard varieties and also practically all of the newer introductions.

Rotundifolia Grapes.—Our experiments in pruning, training and breeding these grapes will be continued. We have about 1000 seedlings well underway, some of which will fruit next season. From these seedlings we hope to secure some valuable varieties.

Asparagus.—Our experiments in breeding asparagus to produce rust resistant plants have been continued, and a few interesting facts have been observed. The results of this work will be published in bulletin form after another season's records. Our block of male plants has produced 50 per cent. more stalks than the female plants and the average size is much larger. Another interesting fact is that the male plants appear to be, as a rule, more resistent to rust than are the female plants. It is our purpose to continue this work another season before publishing the results.

Okra.—Our experiments in breeding okra have been contin-

ued and the type we have been breeding for six years is now very uniform, and I recommend that seed of this variety, which I have named Clemson, be distributed over the State for trial. Figure 1 shows an okra plant of the variety which has been pruned. Figure 2 shows one of the same variety which has not been pruned. The advantage in pruning the okra is that

the stalks may be allowed to grow much closer together in the row and the cultivation can be much more easily done. Where the plants are not pruned, it is necessary to have the rows 4 to 5 feet apart and the plants not closer than 3 feet apart in the row. If the lateral branches are to be pruned, the rows need not be more than 3 feet apart and the plants may stand as close as 15 inches in the row. When pruned and planted close together, as described above, the yield will be 50 per cent more than when planted in wide rows and allowed to put out lateral

branches. As shown in figure 2, very few pods are produced on the lateral branches.

Grafting.—We have some interesting results from experiments in grafting apples with scions and stocks of various lengths. Figure 3, row 1, shows trees grown from stocks 3 inches long and scions the same length. In row No. 2, the stocks were 6 inches; and scions, 6 inches. In row No. 3, stocks were 12 inches; and scions, 12 inches. The illustration shows that the size of the trees in No. 1 and 2, where short scions are used, is much better than those in row No. 3, where both a long scion and stock were employed. It will also be noted that the bodies of the trees themselves are more irregular in shape than those grown from short scions. The root system of rows No. 1 and 2 was even better than the root system of row No. 3. Our experiments along this line will be continued and later a bulletin will be published giving the results.

Respectfully submitted,

C. C. NEWMAN,
Horticulturist.

REPORT OF BOTANIST AND PLANT PATHOLOGIST.

Clemson College, S. C., Oct. 18, 1910.

Prof. J. N. Harper, Director S. C. Experiment Station.

Dear Sir: I respectfully submit the following report of the Botanical Division of the Experiment Station for the fiscal year ending June 30th, 1910. During this time the work on cotton anthracnose, sweet potato rots and on the plant disease survey of the State has been continued. In addition to these, experiments looking to the best methods of controlling some of the common diseases of plants have been undertaken, and since the State seed law went into effect last May, we have been co-operating with the Commissioner of Agriculture, Commerce and Industries in the anlysis of seed and in the enforcement of this law. A short summary of each of these lines of work is given below.

Cotton Anthracnose.

The work with this disease was continued in the greenhouse

last winter and has been carried into the fields this season. In our greenhouse tests we secured additional data which prove that the disease is carried in the seed. A number of seedlings grown from diseased seed were transplanted to the field this spring and careful notes were taken and microscopic examinations of the parts have been made during the season. Seed were taken from diseased bolls last fall and planted in the field this spring and notes taken and examination of the parts of these continued through the season. We have found the disease on leaves and leaf scars of these stalks ever since seedlings came up and now there is an abundance of disease on the bolls. Seed from healthy bolls picked last fall and planted this spring on the land which was in peas and oats last year but cotton the previous year and on which the disease caused 35 per cent loss at that time shows no disease at all this season. On the other hand, doubtful and diseased seed planted on a part of the same land produced cotton which has from 5 per cent. to 20 per cent. of the bolls diseased. This clearly demonstrates that one year's rotation with clean seed will eliminate the disease. Seed were planted from healthy and diseased bolls from same stalk and the progeny of the diseased bolls show an abundance of disease while that of the healthy bolls show very little disease.

A number of farms in the State which are infested with anthracnose have been visited and in practically every case investigated, where the disease has occurred this season for the first time, it is on some susceptible variety which has been planted for only one or two years. And in the majority of cases the seed were bought from farms which are now known to have contained anthracnose, or from seed houses that have made no effort to secure disease-free seed. The same thing is shown by a large number of reports sent in by farmers in various sections of the State. All of this emphasizes the fact that the disease is being spread all over the State in seed taken from fields where the disease occurs. The majority of such seed too are coming from seed houses or from people who are selling some supposedly highly improved variety.

A bulletin giving complete report of this work will be issued at the end of this season.

Sweet Potato Rots.

This work has been continued during the year along the same lines as heretofore. In addition to the plans followed last year, a potato house was constructed last fall and potatoes stored in it in slatted bins 3x4 feet in size. The potatoes were harvested and put in storage November 1st and the temperature of the house was kept at from 70 degrees to 90 degrees F. for the first two weeks. During this time the house was well ventilated. At the end of two weeks the house was closed up and the temperature kept at between 50 and 60 degrees F. during the rest of the winter.

The only potatoes available for storage were affected with black rot and about two months after they were stored this disease was found to be causing considerable rot in the bins. Nectria rot also appeared on these potatoes about the 1st of January and by April 1st, the majority of the 100 bushels stored were destroyed by these two rots. None of the common storage rots such as Rhizopus, Mucor, Penicillium and Fusarium occured. It seems, therefore, that if we have disease-free potatoes to begin with, as we expect to have this fall, this method of storage will prove a success.

Seed Testing.

Since May 1st we have been co-operating with the Commissioner of Agriculture, Commerce and Industry in the enforcement of the seed law which went into effect on that date. The said Commissioner has furnished a man for the analytical phase of this work and has placed him at the disposal of this division. So far we have been engaged in equipping the laboratory for this work and in testing methods of analysis with view of adapting them to our conditions. One clause of the seed law states that no seed which contain a communicable disease shall be considered pure. In this connection we are making an effort to secure a satisfactry method of detecting the presence and the amount of anthracnose in cotton seed. We have the assurance

of Col. Watson that the enforcement of this law will be taken up in earnest in the near future and that we will be furnished with all the seed for analysis that this laboratory can handle. This work is important and we trust will be pushed.

Publications.

In conjunction with Prof. C. C. Newman, a bulletin has been published on "Tomatoes and Tomato Diseases," and articles have been written for the extention work and State newspapers on Cotton Anthracnose, Black Rot of Sweet Potatoes and Corn Ear Rot. A press bulletin has also recently been issued on the Anthracnose Situation in South Carolina.

Correspondence.

The correspondence of this division is constantly increasing and during the past year has demanded more time than ever before. Through such correspondence we have gained much valuable data in connection with the anthracnose investigation, and have secured specimens which have added a great deal to the plant disease survey. Information relative to the control of the various plant diseases has been given out in personal letters, thus furnishing information direct to the people who desire it. The appreciation of this phase of the work is shown by the large increase in the number of nnquiries reecived.

Public State Work.

During the past spring field experiments relative to the control of some of the common plant diseases were undertaken in co-operation with the Division of Entomology of the State. One of the most important of these was a test of the efficiency of self-boiled lime sulphur mixture against scab and brown rot of peaches and plums. A summary of this is given below. Acting President and the Board of Trustees have shown their appreciation of this work by providing for a field assistant and by making appropriation providing for the enlargement of the work for the fiscal year 1910-11.

Respectfully submitted,

H. W. BARRE,

Botanist and Plant Pathologist.

Use of Self Boiled Lime Sulphur in Combating Scab and Brown Rot of Peach.

In co-operation with Prof. Conradi the problem of testing the efficiency of lime sulphur and arsenate of lead in controlling scab, brown rot and cuhculio was undertaken on the farm of Mr. L. P. Boggs at Liberty, S. C. A discussion of the size, location and condition of the orchard is given in Prof. Conradi's article elsewhere in this publication so will be omitted here.

Peach leaf curl and San Jose scale had occurred in this orchard the previous season so thorough application of concentrated lime sulphur was made before the buds began to swell. This probably served to destroy a large part of the brown rot and scab fungi which were present on the limbs and trunk of the trees. In this work flour of sulphur and quick lime were used in equal quantities,—16 lbs. of each to 100 gallons of water. The mixture was made up in the following manner: 32 lbs of lime was placed in a barrel and enough water added to this to slake it. As soon as the lime broke apart well and had slaked sufficiently to cause a violent boiling of the water and lime, an equal quantity (32 lbs.) of sulphur was added and stirred in thoroughly. Enough water was added from time to time to keep any part of the mixture from becoming dry or burning and to make a thick even paste. This boiling was allowed to continue for five or ten minutes, after which the mixture was cooled down by filling the barrel with water. This was used as a stock solution and one-fourth of it used in making each barrel of the spray mixture. This mixture was put on with Gould's Pomona barrel pump and an effect was made to keep the pressue at about 100 lbs. per square inch.

The first application was made on April 21st. The second on June 2nd and 3rd and on the Elberta trees a third application was made on July 28th and 29th.

The three varieties sprayed were Carmine, Elberta and Belle of Georgia. Owing to the location of the orchard and to the fact that the peaches were gathered in small quantities each day for the local market, it was impossible for us to make accurate tubulations of the number of sound and dis-

eased fruits taken from each tree, but the orchard was visited a number of times and sufficient data secured upon which to base the following general conclusions:

On the Carmines the per cent. of fruit affected on the individual trees varied from 5 per cent. to 20 per cent. with an average of 7 per cent. On the Elberta, the individual trees varied from 3 per cent. to 10 per cent. with an average of 5 per cent. No counts were made on the Belle of Georgia but the amount of rot seemed to be about the same as on Carmine. None of the checks produced more than 20 per cent. of sound fruit.

The results with scab were not quite as satisfactory as with brown rot. In may cases where the spraying had not been thorough small scab areas appeared on large numbers (frequently as much as 40 per cent.) of the peaches. In a few cases where the spraying had been done thoroughly very little scab occurred. The per cent. of scab varied on individual trees from 8 per cent. to 40 per cent. The majority of these fruits, however, only had a few scab spots on them and were otherwise perfectly sound. On the unsprayed trees practically every peach showed scab spots.

It seems from this test that is order to control scab completely, it is necessary to have the spray mixture put on in fine enough spray and with sufficient force to cover the entire surface of the fruit. It takes very careful work to do this with a barrel pump, but it can be readily accomplished where power sprayers are used.

There was an unusual amount of rain during the early summer and weather conditions generally were very favorable for the development of rot and scab. Considering the conditions, the equipment, and the thoroughness with which the mixture was put on, we consider the mixture a success. From this and other smaller tests made during the season we feel confident, in fact, that self boiled lime sulphur is the safest and best spray mixture to use against brown rot and peach scab.

Plant Disease Survey of South Carolina.

Report of Progress.

Work on a disease survey of the State was undertaken in co-operation with the Bureau of Plant Industry of the United States Department of Agriculture two years ago and has been continued as opportunity permitted since that time. Other lines of investigation have taken a large part of the time and attention unusually devoted to such projects so this work has been very much handicapped. We have, however, kept an accurate record of specimen of disease sent in and have recorded the occurrence of diseases met with while traveling in various sections of the State. The data at hand are not sufficient to enable us to make a report which is at all complete. Since there has never been a report made on the prevalence of the diseases which occur in the State, however, it seems advisable to publish here what we have on the subject. It is hoped that since appropriations have been made providing for a field assistant and for traveling expenses in connection with the plant disease investigations, we will be able to add much to this report within the next few years.

Alfalfa.

Leaf-spot (Pseudopeziza medicaginis (Lib.) Sacc.) collected on the farm of the South Carolina Experiment Station in Oconee and Pickens counties.

Rust (Uromyces striatus Schroet.) reported from Oconee and Pickens counties.

Apple.—Bitter-rot (Glomerella rufomaculans (Berk.) Sp. and von Schr.) This disease is wide-spread and probably occurs in all parts of the State. Where nothing is done to prevent it, it frequently destroys the entire crop of apples. Small spots which occur on the apples at gathering time spread rapidly after harvesting and destroy the entire fruit. Has been reported from Edgefield, Florence, Lexington, Marion, Newberry, Oconee, Pickens, Richland, Saluda and Union counties.

Black-rot (Schaeropsis malorum Pk.) reported from Newberry county.

Leaf-spot (Coniothyrium pirini (Saac.) Sheldon) reported from Anderson, Marion, Oconee, Pickens and Union counties.

Blight (Bacillus amylovorous (Burr.) DeToni) probably occurs in ever ycounty in the State. Has been especially destructive during the present season, in many cases destroying all of the fruit and fruiting wood soon after blossoming. Reported from Anderson, Colleton, Cherokee, Greenville, Hampton, Marion, Newberry, Orangeburg and Spartanburg counties.

Brown-rot (Sclerotinia fructigena (Pers.) Schrt.) reported from Oconee and Orangeburg counties.

Fly-speck (Leptothyrium pomi (Mont. & Fr.) Sacc.) is wide spread. Does very little damage except to mar the appearance of the fruit. Reported from Anderson, Lexington, Newberry, Marion, Oconee, Pickens, Richland and Sumter counties.

Powdery mildew (Sphaerotheca mali (Duby) Burr) reported on young trees in Oconee and Pickens counties.

Scab (Venturia inaequalis (Cke.) Aderh.) seems to occur only in the western part of th State in and near the mountains. Here certain varieties are badly affected. Reported from Greenville, Oconee, Pickens and Spartanburg counties.

Hypochnose (Hypochonus ochroleucus Noack.) occurs only in moist situations. Reported from Marion county where it was doing considerable damage in one orchard.

Rust (Gymnosporangium macropus Lk.) probably occurs in every county in the State and on such varieties as Red June, Shockley and Grimes' Golden causes considerable damage. Observation at Clemson and at Lexington show that the points brought out by Dr. F. D. Heald in Nebraska in reference to the time of the infection of the cedar hold in this climate. The infection of the apple leaves took place between the 15th and 30th of April in 1909 and about the same time this season. The galls on the cedar were first observed on June 15th at which time they were as large as a pea. The yellow spots on the apple leaves were just beginning to thicken for the formation of cluster cups and the cluster cups on

the native Crategus in the woods nearby were just opening at this time. Mature cluster cups were observed on the apple leaves on the 5th of July. Reported from Anderson, Berkeley, Calhoun, Clarendon, Edgefield, Fairfield, Greenwood, Florence, Lee, Marion, Newberry, Richland, Saluda, Oconee, Lexington, Pickens, Union, Dorchester and Sumter counties.

Sooty-blotch (Phyllachora pomigena (Schw.) Sacc.) reported from Oconee and Pickens counties.

Apricot.—Leaf-curl (Exoascus sp.) reported from Oconee and Pickens counties.

Asparagus.—Rust (Puccinia asparagi DC.) reported from Anderson, Aiken, Oconee and Saluda counties.

Barley.—Covered smut (Ustilago hordei (Pers) Kell & Sw.) reported from Oconee and Pickens.

Leaf-rust (Puccinia simplex (Koern) Erikiss and Henn.) reported from Oconee and Pickens counties.

Bean.—Rust (Uromyces appendiculatus (Pers) Lev.) seems to be wide spread and in Edgefield and Greenwood is reported as causing considerable loss. Reported from Edgefield, Greenwood, Lexington, Oconee and Pickens counties.

Blackberry.—Leaf-spot (Septoria rubi Westd.) reported from Colleton, Oconee and Pickens counties.

Blue-Grass.—Rust (Puccinia poarum Niels.) reported from Oconee and Pickens counties.

Cabbage.—Black-rot (Bacterium campestra (Pam) Erw. Sm.) reported from Greenwood and Newberry counties.

Club-root (Plasmodriophora brassicae Wor.) reported from Bamberg county.

Wilt (Fusarium sp.) reported from York county.

Catalpae.—Leaf-spot (Phyllisticta catalpae (Ell. & Mart.) reported from Oconee and Pickens counties.

Carnation.—Rust (Uromyces carophyllinus (Schrk.) Schrt.) reported from Oconee and Pickens counties.

Celery.—Leaf-light (Cercospora apii Fres.) reported from Oconee and Pickens counties.

Cherry.—Black-knot (Plowrightia morbasa (Schw.) Saac.) is common on wild cherry, (Prunus serotina), throughout the western part of the State. Reported from Newberry, Oconee,

Pickens and Saluda counties.

Brown-rot (Scerotinai fructigena (P) Schrt.) reported from Oconee and Pickens counties.

Leaf-spot (Cylindrosporium padi Karst.) is common on wild chery throughout the State. Reported on cultivated cherry from Anedrson, Lexington, Oconee, Orangeburg and Pickens counties.

Chrysanthemum.—Ruts (Puccinia chrysanthemi Roze.) reported from Anderson, Oconee and Pickens counties.

Powdery mildew (Oidum chrysanthemi Rabh.) reported from Pickens county.

Clover.—Black-spot (Phyllachora trifolii (Pers.) Fekl.) reported from Laurens, Oconee and Pickens counties.

Corn.—Dry-rot (Diplodia zeae (Schw) Lev.) seems to be wide spread and at one place in Darlington county was found to be causing 20 per cent. loss. Also reported from Hampton, Marion, Orangeburg, Oconee and Pickens counties.

Rust (Puccinia sorghi Schw.) reported from Marion, Oconee and Pickens counties.

Smut (Ustilago zeae (Beckm) Unger) occurs in every section of the State. Reported as causing 20 per cent. loss at one place in Lexington county where land had been planted in corn continually. Reported as occurring in Anderson, Lexington, Marion, Edgefield, Newberry, Oconee and Pickens counties.

Cotton.—Angular leaf-spot (Bacterium malvacearum Erw. Sm.) occurs on every section of the State but does very little damage. Reported from Bamberg, Calhoun, Clarendon, Aiken, Darlington, Florence, Lexington, Orangeburg, Richland and Sumter counties.

Rust (Macrosporium nigricantium Atk.) reported from Orangeburg county.

Leaf-spot (Cercospora gossypina Cke.) completely defoliated small areas on Experiment Station farm during August and September this season. Seems to be rather wide spread but has only ben reported from Anderson, Greenwood, Oconee and Pickens counties.

Frosty mildew (Ramularia areola Atk.) is wide spread but causes little damage. Reported from Anderson, Chesterfield,

Darlington, Florence, Lee, Lexington, Marion, Newberry, Richland, Oconee and Pickens counties.

Anthracnose (Glomerella gossypii (South) Edg.) is wide spread. Occurs in one or more localities in every section of the State. It seems to thrive on all kinds of soil and under a variety of conditions and is destructive wherever introduced. Reoprts of losses ranging from 10 to 507 per cent. of the crop are common. On one farm in Chesterfield county where from 10 per cent. to 40 per cent. of the bolls were destroyed, the money loss was over a thousand dollars this season. The annual loss in the State amounts to over a million dollars. Certain varieties such as Cook, Triumph, Excelsior, Mortgage Lifter, Money Maker, Brown No. 1, Christopher, Floradora, Blue Ribbon, are very susceptible to the disease: while Toole, King, Russell's Big Boll, Cleveland's Big Boll and certain others are comparatively free from it. Reported from all of the counties of the State except Charleston, Chester, Georgetown and Lancaster.

Wilt (Neocosmospora vasinfecta (Atk) Erw. Sm.) occurs all through the eastern part of the State and on sandy land through the central part. Frequently destroys the entire crop on badly infested land and makes it impossible to grow anything in the way of cotton except the wilt resistant varieties. Has been reported from Aiken, Bamberg, Berkeley, Calhoun, Clarendon, Colleton, Darlington, Florence, Greenwood, Marionn Marlboro, Newberry, Lexington, Orangeburg, Richland, Saluda, Sumter and Williamsburg Counties.

Leaf-spot (Phyllosticta gossypina Ell. & M.) has occurred during the past two seasons on the cotyledons and leaves of cotton during May and June. When present attacks the majority of the leaves but does not do serious harm. Re ported from Oconee and Pickens Counties.

Cowpea.—Leaf-spot (Cercospora cruenta Saac.) is wide spread but rarely causes serious damage. Has been reported from Bamberg, Darlington, Hampton, Lee, Lexington, Marion, Newberry, Oconee, Pickens, Saluda and Sumter Counties.

Leaf-spot (Amerosporium aeconomicum Ell. & Tracy) is

also wide spread but causes only minor losses. Reported from Hampton, Oconee and Pickens counties.

Wilt (Neocosmospora visinfecta Erw. Sm.) occurs in about same localities and under same conditions as cotton wilt. Frequently destroys entire crops of peas and makes it impossible to grow anything but the Little Iron,—a variety that is immune to the disease. Re ported from Darlington, Dorchester, Colleton, Greenwood, Hampton, Marion, Oconee, Pickens, Richland, Spartanburg and Union Counties.

Cucumber.—Downy mildew (Pseudo-peronospora cubensis (B. & C.) Rostr.) reported from Charleston County.

Egg-Plant.—Blight (Bacillus solanacearum Erw. Sm.) reported from Kershaw County.

Elm.—Powdery mildew (Uncinula sp.) reported from Anderson, Greenville, Greenwood, Marion, Oconee, Pickens and York Counties.

Grape.—Black-rot (Guignardia bidwellii (Ell.) V. and R. is wide spread. Has been observed on the leaves of either of the wild or the cultivated Rotundifolio grapes in every section of the State. Frequently attacks the fruit of his specie but does not cause as great a loss as on the bunch grapes. On some varieties during moist seasons the disease destroys the entire crop. Some varieties prove more susceptible to the rot than others. The most resistant here are the Perkins, Bell, Herman Jager, Presley, Ives, Early Ohio, Hartford, Concord, Goethe, Neva and America. Reported from Anderson, Bamberg, Barnwell, Florence, Colleton, Marion, Lexington, Oconee, Pickens, Richland, Orangeburg and Spartanburg Counties.

Downy mildew (Plasmopora viticola (B. & C.) Berl. and DeToni) reported from Oconee and Pickens Counties.

Lilac.—Powdery mildew (Microsphaera alni (Wallr.) Salm.) reported from Oconee and Pickens Counties.

Maple.—Tar leaf-spot (Rhytisma acerinum (Pers.) Fr.) reported from Oconee and Pickens Counties .

Mulberry.—Leaf-spot (Phyllosticta sp.) reported from Georgetown, Oconee and Pickens Counties.

Leaf-spot (Cercospora moricolo Cke.) reported from Oconee and Pickens Counties.

Pea.—Ascochyta blight (Ascochyta pisi Lib.) reported from Oconee and Pickens.

Wilt (Neuscosmispora sp.) reported from York County.

Peach.—Frosty mildew (Cercosporella persicae Saac.) reported from Oconee and Pickens County.

Powdery mildew (Sphaerotheca pannosa (Wallr.) Lev.) reported from Oconee and Pickens.

Brown-rot (Sclertotinio fructigeno (Pers.) Schrt.), a most wide spread and destructive disease. Occurs in every county of the State and during rainy seasons practically destroys entire peach crop.

Scab (Cladosporium carpophilum Thum.) occurs in every section of the State. Is especially destructive on late varieties.

Rust (Puccinia pruni Pers.) seems to be widely distributed throughout the State. Reported from Lexington, Marion, Oconeee, Pickens and Richland Counties.

Leaf-curl (Exoascus deformans (Berk.) Fckl.) reported from Aiken, Anderson, Darlington, Marion, Oconee, Pickens and Spartanburg.

Pear.—Blight (Bacillus amylovorus (Burr.) DeTonti.) is wide spread and destructive, especially where commercial orchards are cultivated and fertilized so as to keep the trees growing rapidly. Reported from Colleton, Florence, Hampton, Greenville, Lexington, Marion, Newberry, Oconee, Orangeburg, Pickens, Richland, Saluda, Spartanburg and Sumter Counties.

Pecan.—Scab (Fusicladium effusum Wint.) has appeared at a number of widely separated points and seems to be doing considerable damage. One orchard of 500 trees 18 years old, at Summerton has been rendered profitless by this disease during the last few years. The entire crop on two trees in the horticultural grounds here was destroyed by it this year. Seems to be much worse on seedlings than on grafted trees. Reported from Anderson, Charleston, Colleton, Clarendon, Oconee, Orangeburg, Saluda and Sumter Counties.

Plum.—Black-knot (Plowrightia morbosa (Schw.) Saac.) reported from Oconee, Pickens and Saluda.

Plum-pockets (Exoascus sp.) reported from Oconee, Pickens and Saluda.

Leaf-spot (Cylindrosporium padi Karst.) reported from

Oconee and Pickens Counties.

Brown-rot (Shlerotinia fructigena (Pers.) Schrt.) is wide spread and causes considerable damage on the cultivated varieties. Reported from Anderson, Greenville, Oconee and Pickens Counties.

Scab.—Same as peach. Where trees are not sprayed, is causing loss on some of the cultivated varieties.

Rust (Puccinia pruni P.) Reported from Oconee and Pickens Counties.

Potato.—Early-blight (Alternaria solani (E. & M.) J. & G.) seems to be rather wide spread but has only been reported from Oconee and Pickens Counties.

Dry-rot (Fusarium oxysporium Schlecht.) reported from Oconee and Pickens Counties.

Late-blight (Phytophthora infestans DeBy.) Reported from Lancaster County.

Scab (Oospora scabies Thax.) Reported from Greenville, Oconee, Pickens and Spartanburg Counties.

Quince.—Blight (Bacillus amylovorous (Burr.) DeTonti.) Reported from Anderson County.

Rust (Gymnosporangium sp.) Reported from Oconee and Pickens Counties.

Raspberry.—Anthracnose (Gleosporium venetum Speg.) reported from Richland County.

Rose.—Powdery mildew (Spareotheca pannosa (Wallr.) Lev.) is wide spread occurring everywhere the Crimson Rambler and other susceptible varieties are grown. Reported from Anderson, Calhoun, Charleston, Darlington, Hampton, Lexington, Marion Oconee, Orangeburg and Pickens Counties.

Leaf-blotch (Actinonema rosae (Lib.) Fr.) reported from Lexington, Marion, Newberry, Oconee and Pickens Counties.

Rye.—(Puccinia rubigo-vera (D. C.) Wint.) is wide spread and in a few cases has been found causing heavy losses. Reported from Anderson, Darlington, Lexington, Oconee and Pickens Counties.

Smut Grass.—Head blight (Heminthosporium sp.) reported from Bamberg and Hampton Counties.

Sorghum.—Kernel-smut (Sphacelotheca sorghi (Lk.) Clint.) reported from Anderson, Oconee and Pickens Counties.

Strawberry.—Leaf-spot (Sphaerella fragaria (Tul.) Saac.) reported from Oconee and Pickens Counties.

Sweet Potato.—Black-rot (Ceratocystis fimbriata Ell. and Hals.) probably occurs in every county in the State and is causing a great deal more damage than is commonly attributed to it. It not only attacks the potatoes in the field but has been found causing rot in storage. In the potato house here where last winter conditions were controlled so as to prevent the ordinary storage rots, the black rot, which was on the potatoes when they were harvested, spread and caused considerable damage. It seems as though a number of the storage rots enter through the black-rot diseased areas. This makes it appear that the first step in keeping potatoes is to secure them free from this disease. In certain localities in the eastern part of the State, where the planters follow the practice of growing their seed potatoes from cuttings, black-rot causes littletrouble. Reported from Anderson, Lexington, Oconee and Pickens Counties.

White-rust (Albugo impomoeae-panduranae (Schw.) Swingle) is wide spread but causes little damage. Reported from Lexington, Oconee, and Pickens Counties.

Dry-rot (Lasiodiplodio tubericola Ell. & Ev.) reported from Oconee and Pickens Counties.

Soft-rot (Rhizopus migricans Ehrb.) occurs in every section of the State and where potatoes are not properly stored frequently destroys large quantities. Reported from Anderson, Colleton, Lexington, Lee, Marion, Newberry, Oconee, Pickens, Richland and Saluda Counties.

Leaf-spot (Phyllosticta bataticola Ell. & Mart.) is wide spread but causes no serious damage. Reported from Bamberg, Colleton, Hampton, Lexington, Newberry, Oconee and Pickens Counties.

Stem-rot (Nectria ipomoeae Hals.) has not been very widely reported but is probably more common than reports would indicate. Has caused more trouble on potatoes in storage here than it has in the field. Last winter a large majority of the potatoes that rotted in the storage house were found to be affected with Nectria. This seems to be a new role for Nectria, and is a phase of the trouble that is liable

to prove more destructive than the disease does as it occurs in the field. Only reported from Oconee and Pickens Counties.

Sycamore.—Anthracnose (Gloeosporium nervisequum Fckl.) Saac.) found destroying a whole avenue of trees at Bamberg. Reported from Bamberg, Oconee and Pickens Counties.

Leaf-blight (Pestalozzia sp.) is of minor importance. Reported from Oconee and Pickens Counties.

Tobacco.—Wilt, bacterial, reported from Clarendon County.

Tomato.—Leaf-spot (Septoria lycopersica Speg.) is wide spread and frequently completely defoliates plants. Reported from Chester, Clarendon, Greenwood, Orangeburg, Oconee and Pickens Counties.

Leaf-mold (Cladocorium fulvum Cke.) reported from Spartanburg County.

Black-spot (Macrosporium solani Ell. & Mart.) reported from Clarendon, Chester, Darlington and Union Counties.

Blossom-end rot (Fusarium solani Mart.) reported from Florence, Oconee, Pickens and Union Counties.

Wilt (Bacillus solanacearum, Smith) reported from Florence and Marion Counties.

Wilt (Fursarium sp.) reported from Clarendon County.

Vetch.—Blight (Ascochyta viciae, Trail) found causing spots on leaves and pods of common vetch. Reported from Oconee and Pickens Counties.

Walnut.—Leaf-spot (Marsonia juglandis Lib.) reported from Oconee, Pickens and York Counties.

Watermelon.—Leaf-spot (Cercospora cucurbitae Ell. & Ev.) reported from Colleton and Florence Counties.

Anthracnose (Colletotrichum lagenarium Ell. & Hale) was found to have destroyed entire crop at one place in Edgefield County. Frequently makes production of second crop impossible. Reported from Aiken, Edgefield, Florence, Lee, Oconee and Pickens Counties.

Wilt (Neocosmospora vasinfecta Erw. Sm.) seems to have about same distribution as cotton and cowpea wilts. Destroys entire crop wherever introduced and makes growing of watermelons impossible. Reported from Bamberg, Darlington,

Florence, Greenvile, Lexington, Lee, Richland and Saluda Counties.

Wilt (Bacillus tracheiphilus Erw. Sm.) reported from only one locality in Florence County. Probably occurs in other localities besides this.

Wheat.—Leaf-rust (Puccinia rubigo-vera (D. C.) Wint.) is wide spread and frequently very destructive. Reported from Oconee and Pickens Counties.

Loose-smut (Ustilago tritici (Pers) Jens.) is wide spread and in some cases causes considerable loss. In one field on the Experiment Station farm this season the loss averaged 10 per cent. Reported from Oconee and Pickens Counties.

REPORT OF ENTOMOLOGIST.

Clemson College, S. C., Oct. 11, 1910.

Prof. J. N. Harper, Director, S. C. Experiment Station.

Dear Sir: The work of this year was a continuation of last year, except that one project under the Adams Fund was added. The division now has two projects under the Adams Fund, viz., (1) Investigation of Strongyloid parasites of the digestive tract of ruminants, (2) The relation of temperature to insect activity.

Since our last annual report or Strongyloid parasites (22nd Annual Report, pp. 65-89), the facilities for continuation along the same lines were handicapped owing to the absence of heavy infestations among the young cattle at this Station during the season 1909, and no sickness or deaths having so far occurred during the present season, the work of the entomologist has been concentrated on detailed study of the anatomy of the hook worm and stomach worm. This work is in progress but not sufficiently advanced for a report at this time. The season generally has been unfavorable to the development of hook worms and stomach worms in the free stages, owing to the severe drouths during the summer. The work will be continued during next year with an attempt to discover some definite causes for some of the phenomena of Strongyloid diseases.

The work on temperature relations was begun at the be-

ginning of last season but owing to the preparation necessary for an investigation of this kind, only a limited amount of progress was made.

Collections.

Important additions have been made to the scientific collections bearing upon the investigations in progress. No attempt has been made at museum work owing to lack of time,—this being considered as not of sufficient vital importance as to sacrifice any part of the main investigations thereto. All material is accessioned with cross references and easily available to the workers of the division.

Correspondence.

The large correspondence with farmers has been of great value in gaining a general knowledge of the conditions existing in various parts of the State. Every outbreak is recorded in the record system of the Station.

Publications.

This division has continued to issue circulars of information designated as office forms to facilitate the heavy correspondence. Fifty such forms are in use now and are distributed from time to time as outbreaks occur, or are anticipated. Bulletin No. 150 was issued giving information on farm management for controlling field crop insects. This bulletin is based on two years' observation in this State. It is in a preliminary form and will be revised and enlarged during the next season. Insect outbreaks are subject to well defined laws. Unfortunately many of these laws are not yet understood but progress is being made constantly.

Farmers' Institute Work.

The entomologist attended a number of farmers' institutes during the year. Besides miscellaneous information given, the field and fruit crop insects received principal attention. Farmers' institute work is an efficient means for discovering the principal needs of the farmers. Co-operative experimental work as well as demonstration work was arranged at these institutions to be carried out next season.

Co-operative Work.

This divison is carrying on considerable co-operative ex-

perimental work with farmers and this work is productive in so far that it helps the farmers on the one hand and is of much benefit to this division on the other hand. This work is thoroughly practical and is an efficient agency in keeping this division informed as to the conditions in various parts of the State as well as to the needs of the people. The Divisions of Botany and Entomology jointly, did some very successful field work on the control of brown rot and plum curculio on peach, and scab and codling moth an apple. This work is much enlarged and will be carried into many different points of the State next spring.

Co-operative Work With the Bureau of Entomology of the United States of Agriculture.

Co-operation with the Bureau of Entomology is continued and as heretofore is of much help in our co-operative experimental work. With the assistance of the Bureau, Mr. W. A. Thomas, of this division, can be kept in the field, confining his efforts chiefly to the cotton and corn root louse in the heavy cotton counties of eastern South Carolina, and the cotton and corn wire-worm which is creating havoc in the southwestern part of the State, principally in Colleton County. The life history of the cotton and corn root louse is being worked out; its habits are studied and food plants determined. Experiments in rotation, repellants and cultivation are in progress. Its parasites, attendant ants and the effect of climate are carefully observed.

The work on wire-worms is co-operative between the entomologist and chemist is along similiar lines. Important results were secured in the experiments during the past year and this work will be continued on a larger scale this coming spring. A full report on this work will be issued in bulletin form in the near future.

Miscellaneous State Work.

A large amount of work is done investigating miscellaneous insect outbreaks. It is the intention of this division to give personal help whenever possible in case the recommendations

cannot be carried out through correspondence. This includes the spraying of orchards, groves, street trees, fumigation; the investigation of outbreaks of field crop insects, such as the red spider, boll worm, grain lice, etc.

WORK PROPOSED.

The work is well laid out and clearly defined. The lines of work indicated above are in progress and will be continued during next year.

Respectfully,
A. F. CONRADI,
Entomologist.

REPORT OF CHEMIST.

Clemson College, S. C., Oct. 13, 1910.

Prof. J. N. Harper, Director, S. C. Agricultural Experiment Station.

Dear Sir: I respectfully submit the following report of the work of the Chemical Division of the Station for the year ending June 30, 1910.

The work may be classed as: (I) Miscellaneous, (II) A continuation of the sweet potato investigation, (III) A comparison of various animal sources of nitrogen with nitrate of soda as a standard, (IV) A study of basic slag, (V) A study of the causes of the death of hogs from cottonseed meal feeding, and (VI) Co-operative work.

I. The miscellaneous work includes the following analyses: 15 samples of fertilizer, 13 samples of feeds, 10 samples of Paris green, 3 samples of muck, 3 samples of lime, 2 samples of soot, 35 samples of soil, 1 sample of phosphate rock, and 1 sample of marl,—making a total of 83 samples.

Some of the fertilizer analyses are included in Bulletin No. 151, "Soils and Fertilizers," which is made a part of this report; others are reserved for publication in connection with our work on basic slag.

The samples of feeds analyzed appear below in tabular form. Two of the feed analyses are of special interest; The analysis of beet pulp and the analysis of kudzu vines. A comparison of the analysis of beet pulp with that of corn meal is given below:

	Sample No. 1095 Beet Pulp. Lbs. per 100	Feeds and Feedings. p.619-Henry Corn Meal. Lbs. per 100.
Water	6.47	15.00
Crude fat	2.36	3.80
Crude ptotein	9.88	9.20
Crude fibre	19.81	1.90
Crude ash	4.33	1.40
Nitrogen free extract	57.15	68.70
Totals	100.00	100.00

We note by this comparison that the number of pounds per 100 of water is much lower in the beet pulp than in the corn meal, therefore the dry matter is correspondingly higher in the beet pulp; but this is more than off-set by the very high fibre content of the beet pulp. They are fairly close together with regard to fat and protein. The corn meal contains about 11.5 per cent. more nitrogen-free extract than the beet pulp, and nitrogen-free extract is quite a problem with the Southern stockman. He has an abundance of protein in his cottonseed meal and leguminous forages, when the ration is properly balanced. Crude fibre is much less readily digested than nitrogen-free extract.

Another feed analysis of interest is that of kudzu vines. This sample was furnished by Mr. Hale Houston, of Clemson College, S. C. In Bailey's Cyclopedia of American Horticulture, N.-Q, p. 1465, kudzu (Pueraria thunbergiana) is described as follows: "A hardy vine, remarkable for the great rapidity of its growth, and most useful for covering arbors and verandas. From a well established root, vines will grow 40 to 60 feet in a single season, producing a profusion of very large leaves. In the North, the plant dies to the ground in winter; but, in the South, the top becomes woody."

This is a leguminous plant, and, as the analysis shows, it

might be made useful as a soil improver and perh ...s also as a forage crop, although the trailing nature of its gr ...vth might make it difficult to cut. A comparison of the analy ... of kudzu vines with that of the cowpea vines, follows:

	Sample No. 1096 Kudzu Vine.	Sample No. 134 Cowpea Vine.	Sample No. 1096. ...r dried)	Feeds and ...ing, p. 622. Cowpea (ha...
Water	69.40	87.76	7.	10.7
Crude fat	1.05	0.61	3.	2.2
Crude protein	5.48	2.63	16.	16.6
Crude fibre	8.25	3.56	25.	20.1
Crude ash	2.24	1.47	6.	7.5
Nitrogen-free extract	13.58	3.97	41.	42.9
Total	100.00	100.00	100.(	100.00

The analysis (134) of cowpea vines is taken from ... the record book of the S. C. Experiment Station. It will h ...oted that the moisture content of the kudzu vines was about ... per cent. less than that of the cowpea vines. This may be ac ...unted for, in some measure, by the age of the vines whe ...ut. The analyses of the hays from the two crops are very ...arly the same. Below is given the composition on a mo ...re free basis, which would, perhaps, be the fairest means ... comparison.

	Sample No. 1096. Kudzu Vine (moisture free)	Average of 8 Analyses Cowpea Vine (moisture free)
Crude fat	3.44	2.46
Crude protein	17.93	18.59
Crude fibre	26.96	22.51
Crude ash	7.33	8.40
Nitrogen-free extract	44.34	48.04
Total	100.00	100.00

Below given Table I.—Feed analyses 1909-1910.

TABLE OF FEEDS.—1909-1910.

Sample No.	Analysis made for	Date of Analysis	Water	Crude Protein	Crude fat	Crude Fibre	Crude Ash.	Nitrogen-free Extract.	Total.
1075 Rice m	S. G. Stoney...	10-27-'09	9.44	11.06	10.34	9.01	7.57	52.58	100.00
1076 C. S. M	E. Barnett.....	10-27-'09	8.40	37.50	7.93	9.72	6.32	30.13	100.00
1077 Bran	E. Barnett.....	10-27-'09	10.78	16.69	5.23	12.57	6.14	48.59	100.00
1095 Beet pu	E. Barnett.....	10-27-'09	6.47	9.88	2.36	19.81	4.33	57.15	100.00
1096 Kudzu	H. Houston.....	1-21-'10	7.07	16.66	3.20	25.05	6.81	41.21	100.00
1098 Rice me	S. G. Stoney...	1-21-'10	9.70	12.54	13.44	7.99	9.34	48.99	100.00
1204 Wheat	E. Barnett.....	5-10-'10	12.02	17.35	4.47	5.80	4.99	55.37	100.00
1205 C. S. m	E. Barnett.....	5-10-'10	6.27	42.38	10.23	6.64	6.12	28.36	100.00
1206 Wheat	E. Barnett.....	5-10-'10	9.87	16.13	5.10	5.76	3.81	59.33	100.00
A16W Mixed ed ...	E. J. Watson..	5-28-'10	12.91	10.63	4.13	1.88	2.40	68.05	100.00
B16W Mixed ed ...	E. J. Watson..	5-28-'10	12.25	11.13	5.15	2.86	2.05	66.56	100.00
C16W Mixed ed ...	E. J. Watson..	5-28-'10	9.72	13.69	7.24	8.35	6.79	54.21	100.00
1231 Carolina Rice meal	S. G. Stoney...	6-24-'10	10.38	12.19	14.00	7.47	8.73	47.23	100.00

PARIS GREEN.

Paris green is an aceto-arsenite of copper, and is prepared by adding a thin paste of basic copper acetate in water to a boiling solution of arsenious oxide in water. Some acetic acid is then added, and the mixture boiled until the precipitate is of the desired shade. Paris green is almost entirely used as an insecticide; it is little used as a pigment, on account of its poisonous property.

For the use of Paris green as an insecticide, both in the liquid and in the dry condition, the reader is referred to Bulletin 141 S. C. Experiment Station, pp. 12-13.

The great danger to the plant foliage is the presence of uncombined or water soluble arsenious oxide. This is especially true under Southern conditions, and is probably accounted for by the prevailing heat and moisture; and possibly the delicate foliage is more readily scalded than the foliage farther north. This scalding of the plant foliage can be prevented within certain limits, by adding the milk of lime, made by slaking 3 lbs. of good lump lime to each pound of Paris green. In this case, the lime will combine with the soluble arsenious oxide forming an insoluble compound. The limit allowed for soluble arsenious oxide in Paris green in many of the States, is 4 per cent. while in some, it is only 3.5 per cent,—

the latter limitation would probably be better under our climatic conditions. In the determination of water soluble arsenious oxide in the samples examined, the method used was (f) p 27, Bulletin 107 (revised.)

We have often heard the opinion expressed that South Carolina is the dumping ground for insecticides of poor quality. In order to ascertain the quality of the Paris greens offered for sale in South Carolina, it was deemed expedient to purchase some samples on the open market. With this object in view, Mr. W. A. Thomas, State Entomologist, at my request, bought 8 lots from different dealers, and the writer also bought 2 lots from different dealers, the object being to procure as many brands as possible.

Description of Samples.

Sample No. 1016, purchased from China's Drug Store, Sumter, S. C., by W. A. Thomas in April, 1909.—Seller said that the material was bought directly from the manufacturer, I. Pfeiffer, New York. Weight not given. Warranted strictly pure Paris green. Price 15 cts. per package. Sold in sealed package.

Sample No. 1017, purchased from DeLorme's Pharmacy, Sumter, S. C., by W. A. Thomas, in April, 1909.—Seller said that it was never kept in stock longer than 2 years. Manufactured by I. Pfeiffer, New York. Weight given by seller as one-fourth pound. Waranted strictly pure Paris green. Price 15 cents per package. Sold in sealed package.

Sample No. 1018, purchased from C. W. McMillan, Druggist, Columbia, S. C., by W. A. Thomas, in April, 1909.—Seller said that it had been purchased from Murray Drug Co., Columbia, S. C. Manufactured by Fred L. Lavanburg, New York. Weight one-fourth pound printed on package. Warranted strictly pure Paris green. Price 15 cents per package. Sold in sealed package.

Sample No. 1019, purchased from Wingfield Drug Co., Columbia, S. C., by W. A. Thomas, in April, 1909. Seller said that it had been purchased from Murray Drug Co., Columbia, S. C. Manufactured by Fred L. Lavanburg, New York. Weight one-fourth pound, printed on package. Warranted

strictly pure Paris green. Price 15 cents per package. Sold in sealed package.

Sample No. 1020, purchased from Bryan E. Minot, Columbia, S. C., by W. A. Thomas in April, 1909. Seller said that it had been purchased from Murray Drug Co., Columbia, S. C. Manufactured by E. J. Barry, 18 Cliff St., New York. Weight one-fourth pound printed on package. Strictly pure Paris green. Price 15 cents per package. Sold in sealed package.

Sample No. 1021, purchased from Lipscomb Drug Co., Columbia, S. C., by W. A. Thomas in April, 1909. Seller said that it had been purchased from Murray Drug Co., Columbia, S. C. Manufactured by Fred L. Lavanburg, New York. Weight one-fourth pound, printed on package. Warranted strictly pure Paris green. Price 15 cents per package. Sold in sealed package.

Sample No. 1022 purchased from Hudgins & Co., Columbia, S. C., by W. A. Thomas, in April, 1909.—Seller said that it had been purchased from Murray Drug Co., Columbia, S. C. Manufactured by Fred L. Lavanburg, New York. Weight one-fourth pound, printed on package. Warranted strictly pure Paris green. Price 25 cents per package. Sold in sealed package.

Sample No. 1023, purchased from Lorick & Lowdrance, Columbia, S. C., by W. A. Thomas, in April, 1909.—Seller said that it had been purchased direct from the factory of the Jas. A. Blanchard Co., New York. Dealer keeps both in keg (bulk) and in packages. Sample purchased from bulk at price of 50 cents per pound.

Sample No. 1024, purchased from McFall's Pharmacy, Anderson, S. C., by T. E. Keitt, in April, 1909. Manufactured by Adler Color & Chemical Works, New York. No weight given on package, seller claimed one pound. Price 50 cents per package. Sold in sealed package.

Sample No. 1025, purchased from W. E. Atkinson, Druggist, Anderson, S. C., by T. E. Keitt, in April, 1909. Manufactured by E. J. Barry, 18 Cliff St., New York. Weight printed on package one-fourth pound. Strictly pure Paris green. Price 10 cents per package. Sold in sealed package.

The samples were weighed gross and net. The weights and prices are shown in the following table:

TABLE II.—SHOWS GROSS AND NET WEIGHT OF PARIS GREENS AND COST PER POUND, AS SOLD AND ACTUAL.

Sample No.	Manufacturer's Address.	Dealer's Address.	Gross Weight Lbs.	Net weight Lbs.	Gross Weight + or —	Net Weight + or —	Price Sold per Lb.	Price per Lb. Net.
1016	I. Pfeiffer, New York...	China's Drug Store, .. Sumter, S. C.	1.022	0.958	+.022	—.042	$0.60	$0.626
1017	I. Pfeiffer, New York.	DeLorme's Pharmacy, Sumter, S. C.	1.307	1.201	+.307	+.201	0.60	0.500
1018	Fred L. Lavanburg, ... New York.	C. W. McMillan. ... .. Columbia, S. C.	1.298	1.166	+.298	+.166	0.60	0.515
1019	Fred L. Lavanburg, ... New York.	Wingfield Drug Store, Columbia, S. C.	1.263	1.130	+.263	+.130	0.60	0.531
1020	E. J. Barry, ... New York.	Bryan E. Minot,.... .. Columbia, S. C.	0.980	0.848	—.020	—.152	0.60	.708
1021	Fred L. Lavanburg, ... New York.	Lipscombe Drug Co., Columbia, S. C.	1.219	1.078	+.219	+.078	0.60	0.557
1022	Fred L. Lavanburg, ... New York.	Hudgins & Co., ... Columbia, S. C.	1.351	1.209	+.351	+.209	1.00	0.827
1023	Jas. A. Blanchard, ... New York.	Lorick & Lowrance. .. Columbia, S. C.	1.038	1.027	+.038	+.027	0.50	0.487
1024	Adler Color & Chem. Co. New York.	McFall's Pharmacy, .. Anderson, S. C.	1.087	1.020	+.081	+.020	0.50	0.490
1025	E. J. Barry, ... New York.	W. E. Atkinson,.... ... Anderson, S. C.	1.210	1.077	+.210	+.077	0.40	0.371

Paris green usually contains close to 55 per cent. of total arsenious oxide; and, as has already been stated, the maximum amount of soluble arsenious oxide allowable in most States is 4 per cent. However, in Idaho, 6 per cent has been adopted as the maximum. The climatic conditions for Idaho are entirely different from those of South Carolina.

In analyzing the samples, the following determinations were made: Moisture, sand, sulphuric acid calculated as sodium sulphate copper oxide, total arsenious oxide, and water soluble arsenious oxide after ten days digestion in previously boiled distilled water—shaking about eight times per day. The acetic acid is gotten by substracting the sum of the moisture, sand, sodium sulphate, copper oxide, and total arsenious oxide from 100.

Table III. gives the chemical analyses of the samples of Paris green.

TABLE III.—CHEMICAL ANALYSES OF PARIS GREENS.

Address of Manufacturer.	Address of Dealer.	Sample No.	Per cent Moisture.	Per cent. Sand.	Per cent. SO_3 Calc. as Sodium Sulphate.	Per cent. Copper Oxide.	Per cent. Total Arsenious Oxide.	Per cent. Water Soluble Arsenious Oxide.	Per cent. Acetic Acid.
Pfeiffer, ... New York.	China's Drug Store, Sumter, S. C.	1016	1.34	0.08	1.12	30.32	54.62	2.66	12.52
Pfeiffer, New York.	DeLorme's Pharmacy, Sumter, S. C.	1017	1.42	0.06	1.81	30.23	54.96	4.41	11.52
d L. Lavanburg, New York.	C. W. McMillan, ... Columbia, S. C.	1018	1.27	0.05	1.20	29.98	56.69	1.82	10.81
d L. Lavanburg, New York.	Wingfield Drug Store, Columbia, S. C.	1019	1.38	0.02	1.36	31.35	56.57	1.82	9.32
J. Barry, ... New York.	Bryan E. Minot, Columbia, S. C.	1020	1.25	0.11	0.57	30.79	56.73	0.61	10.55
d L. Lavanburg, New York.	Lipscomb Drug Co., Columbia, S. C.	1021	1.28	0.05	0.79	30.66	55.99	1.57	11.23
d L. Lavanburg, New York.	Hudgins & Co., Columbia, S. C.	1022	1.26	0.07	1.10	30.79	57.49	1.82	9.09
A. Blanchard Co., New York.	Lorick & Lowrance, Columbia, S. C.	1023	1.21	0.03	0.75	30.43	56.18	2.54	11.40
er Color & Chem. Co. New York.	McFall's Pharmacy, Anderson, S. C.	1024	1.25	0.04	1.14	29.60	56.14	3.54	11.83
J. Barry, ... New York.	W. E. Atkinson, Anderson, S. C.	1025	1.14	0.03	1.14	28.75	57.54	1.82	11.40

These samples are unadulterated, and the analyses show them to be a high grade lot of Paris greens; only one is slightly over the usual 4.0 per cent. limit for water soluble arsenious oxide, and one is slightly under-weight gross.

Mucks.—Three samples of swamp muck were analyzed. Two of these samples were sent in by Mr. Samuel Dibble of Bowman, S. C. The analyses are as follows and represent the materials as received:

	Sample No. 1048.	Sample No. 1049.
Water	74.17	71.61
Organic matter (Loss on ignition)	14.39	17.80
Sand	11.44	10.59
Total	100.00	100.00

Fertilizer analyses showed the following percentages of phosphoric acid ammonia, and potash:

	Sample No. 1048.	Sample No. 1049.
Phos. acid ($P\ O_5$)	0.10	0.09
Nitrogen equivalent to ammonia (NH_3)	0.53	0.56
Potash (K_2O)	0.01	0.01

These materials contain about the same amount of organic matter, and about the same amount of ammonia equivalent of nitrogen that we find in barnyard manure (not stable manure); but decidedly less of the mineral elements. Some use might be made of this material by composting it with about 100 to 150 lbs. of acid phosphate and about 20 lbs. of muriate of potash or 80 lbs. of kainit to the ton of muck. The reason that the ammonia, or rather nitrogen content of this material, is so hight may be accounted for by the fact that it has been preserved under conditions that hinder nitrification; the exclusion of air, the lack of heat, and a very wet condition. If this material were applied to lands that are very deficient in organic matter, after having been composted as suggested above, along with a small application of nitrate of soda to furnish immediately available nitrogen, we would expect good results, because our climatic conditions are excellent for rapid nitrification.

A third sample of muck, which came from an area which had been freshly drained, was analyzed for Mr. G. L. Bell, of Aiken, S. C. The analysis follows:

	Sample No. 1202.
Water	27.27
Sand	52.00
Organic matter (Loss on ignition)	20.73
Total	100.00
Nitrogen equivalent to ammonia	1.52 per cent.

These three samples of muck may be gotten on a comparable basis by calculating to moisture-free material:

	Sample No. 1048.	Sample No. 1049.	Sample No. 1202.
Sand	44.29	37.30	71.50
Organic matter (Loss or ignition)	55.71	62.70	28.50
	100.00	100.00	100.00
Nitrogen equivalent to ammonia	2.05	1.97	2.10

Lime.—The question of liming is one that is beginning to

occupy the attention of many of our farmers. On some types of land, lime gives most excellent results; while, on many soils, it shows no improvement. It is highly advisable that the farmer try it in a small way before going at it on a large scale, and that he thoroughly disabuse his mind of the idea that lime is a fertilizer. Lime is not a fertilizer, but is what is known as an amendment, that is, it has such an effect that it promotes desirable conditions in some soils, rendering available plant food which had formerly been unavailable, and bringing about a condition in the soil most favorable to helpful micro-organisms. It also neutralizes the acidity of soils. Generally speaking, we may safely say that if a soil needs lime at all, it needs a liberal application.

If it has been demonstrated that a soil needs lime, two questions confront the farmer: (1) In what form shall it be applied, and (2) How shall it be applied? There are several froms of lime met with on the market; ground limestone, quick lime, oyster shell lime, and lime that is called by the general term agricultural lime.

Ground lime is the finely ground limestone rock, which can be readily handled and applied without inconvenience to the person making the application. It lacks the caustic action of quick lime, and it does not act upon the organic matter of the soil so strongly. Ground lime is in the carbonate form, and we must bear in mind that it contains just 56 per cent. of lime, reckoned as calcium oxide; therefore, it is necessary to haul a greater number of pounds in this form to get the same number of pounds of actual lime. It has the advantages of being easily handled, it is not necessary to slake it, and it is less drastic in its action than some other forms, because it does not break down the humus of the soil so rapidly.

Quick lime is the burned limestone rock, is very caustic in its action, and is very inconvenient to handle. Before applying it, it should be slaked either with water and then covered with earth, or by being covered with wet earth. The most convenient way to accomplish this is to place the quick lime at intervals in the field and cover with moist earth. This is the most concentrated form in which lime can be bought.

Oyster shell limes is made from the oyster shells found along

the coast. We have analyzed two samples of the product of Varn & Platt of Meggetts, S. C. It is either an incompletely burned water slaked oyster shell lime, or else a completely burned partly water slaked and partly air slaked product. It is handled without inconvenience, but is not in nearly so concentrated a form as the quick lime.

The product that is sometimes called agricultural lime, is the partly air slaked material found around the burners, and consists of a mixture of oxide of lime, hydrate of lime, and carbonate of lime. This is also a general term which is sometimes applied to any of the above named products.

Below are given lime determinations of two samples, one of ground limestone received from Gager Lime Manufacturing Co., Chattanooga, Tenn., and the other of oyster shell lime received from Varn & Platt, Meggetts, S. C., through their sales agent, Mr. E. L. Commins.

Sample No. 1091 receivd from Gager Lime Mfg. Co., Chattanooga, Tenn.

Sample No. 1190 received from Mr. E. L. Commins, Sales Agent, Varn & Platt, Meggetts, S. C.

	Sample No. 1091.	Sample No. 1190.
Lime calculated as calicum oxide (CaO)	49.82	58.38
Equivalent to carbonate of lime ($CaCO_3$)	88.97	

Below is given a complete analysis of official sample No. 156 which was furnished through the kindness of Mr. H. M. Stackhouse, Secretary of the Fertilizer Control. This sample had been previously subjected to the usual fertilizer analysis. We have made use of the Control analyses of phosphoric acid and potash. This sample was numbered in our series 1203.

	Analysis of Sample No. 1203.
Moisture (H_2O)	12.39
Calcium oxide (CaO)	56.29
Magnesium oxide (MgO)	1.20
Oxides of iron and alumnia (Fe_2O_3 -Al_2O_3)	4.45
Loss on ignition	22.54
Insoluble	2.53

Total phosphoric acid (P_2O_5)	0.38
Potash (K_2O) (soluble in water)	0.17
Sodium oxide (Na_2O)	*Undertermined.*
Total	99.95

Probably combined as follows:

	Sample No. 1203
Moisture (H_2O)	12.39
Calcium Carbonate ($CaCO_3$)	12.07
Calcium hydrate ($Ca(OH)_2$)	65.09
Magnesium carbonate ($MgCO_3$)	2.51
Tricalcium phosphate ($Ca_3(PO_4)_2$)	0.55
Oxide of iron and alumina (Fe_2O_3 Al_2O_3)	4.45
Insoluble	2.53
Potasium carbonate (K_2CO_2)	0.17
Sodium oxide (Na_2O)	Undetermined.
Total	99.95

The high percentage of oxide of iron and alumina is accounted for by Mr. Commins' statement that iron pyrites was added before burning.

In regard to the application of lime, it is not considered good agricultural practice to apply it immediately before planting, for two general reasons: (1) The germination of the seed may be impaired by the action of the caustic forms, (2) Lime is valuable for the chemical, physical, and biological activities produced, therefore, it is well to have these activities well underway before the crops are planted.

Soot.—Two samples of soot were received from Mr. J. H. McHugh, Clemson College, S. C. Upon inquiry, I learned that sample No. 1233 came from the lower part of the furnace, and that sample No. 1234 came from the combustion chamber of the boiler at the College power plant.

Sample No. 1233 is black in color and neutral to litmus test; sample No. 1234 is reddish yellow in color and gave an alkaline reaction to litmus.

	Sample No. 1233.	Sample No. 1234.
Water (H_2O)	28.10	29.92
Insoluble silica (SiO_2)	34.66	51.20
Soluble silica (SiO_2)	0.08	0.23
Total phosphoric acid (P_2O_5)	0.61	0.90
Ferric oxide (Fe_2O_3)	5.05	5.67
Alumina (Al_2O_3)	3.80	5.49
Calcium oxide (CaO)	2.21	3.49
Water soluble potash (K_2O)	0.05	0.06
Loss on ignition	24.91	1.61
Sodium oxide (Na_2O)	Not determined	Not determined.
Magnesium oxide (MgO)	Not deretimined.	Not determined.
Total	99.47	98.57

These analyses show that it would not be profitable to make use of this grade of soot for fertilizing purposes, unless the material had to be hauled away anyway and could be applied to a nearby field.

Soil Analyses.

The Station chemist has been called upon to make complete or partial analyses of 35 samples of soil. The greater part of this work was done for Mr. A. G. Smith of the Division of Farm Management of the Department of Agriculture. These samples were taken from four soil types on the farm of Mr. A. E. Gonzales near Columbia, S. C., where Mr. Smith is carrying on some experiments which are intended to extend over a long period of time. On three of these types the samples were taken every 6 inches, to the depth of 36 inches; on the fourth, they were taken every 6 inches to the depth of 30 inches,—making 23 samples in all. Both mechanical and chemical analyses were made of each of these samples and the lime requirement was determined in terms of hydrate of lime according to the Hopkins Method, the soil weights used being those given by King—Physics of Agriculture—p. 128.

Soil Series I.

Mr. Smith writes, "The first series of samples was taken

from a level field that had been planted for years practically without number."

Mechanical Analyses.

Laboratory No. Series I.	1052 Area I.	1053 AreaII.	1054 AreaIII.	1055 AreaIV.	1056 AreaV.	1057 AreaVI
Greater than 2mm..	1.0	1.0	1.0	1.0	1.0	2.0
Less than 2 greater tan 1....	10.0	9.0	12.0	16.0	15.0	23.0
Less than 1 greater than 1-2	23.0	21.0	24.0	23.0	22.0	17.0
Less than 1-2	66.0	69.0	63.0	60.0	62.0	58.0
	100.00	100.00	100.0	100.0	100.0	100.0

Chemical Analyses.

Silica and Insol	96.979	97.503	97.802	95.669	93.697	92.348
Potash (K2O)	0.176	0.243	0.149	0.131	0.150	0.195
Soda (Na2O)	0.498	0.599	0.448	0.541	0.303	0.410
Lime (CaO)	0.114	0.084	0.104	0.079	0.079	0.105
Magnesia (MgO)	0.056	0.065	0.100	0.076	0.112	0.101
Manganese oxide (Mn3O4)....	0.255	0.045	0.019	0.095	0.085	0.195
Ferric oxide (Fe2O3)	0.311	0.427	0.350	0.777	1.049	1.282
Alumina (Al2O3)	0.536	0.715	0.775	2.027	3.123	3.697
Phos. pentoxide (P2O5)	0.039	0.019	0.011	0.016	0.029	0.032
Loss on ignition	1.335	0.942	0.602	0.934	1.120	1.521
Sulfur trioxide (SO3)	0.106	0.049	0.103	0.069	0.093	0.069
Total	100.405	100.691	100.463	100.414	99.840	99.962
Nitrogen	0.090	0.060	0.048	0.048	0.048	0.024

Lime Requirement.

81 lbs.	81 lbs.	90 lbs.	90 lbs.	101 lbs.	101 lbs.

Soil Series II.

Again quoting from Mr. Smith,—"The second series was taken from a field that had been farmed for perhaps ten years, although I have no definite information."

Mechanical Analyses.

Laboratory No. Series II.	1058 Area I.	1059 AreaII.	1060 AreaIII.	1061 AreaIV.	1062 AreaV.	1063 AreaVI.
Greater than 2 mm.	1.0	1.0	1.0	2.0	3.0	2.0
Less than 2 greater than 1 ..	12.0	12.0	12.0	14.0	27.0	24.0
Less than1 greater than 1-2...	17.0	17.0	19.0	18.0	17.0	18.0
Less than 1-2...	70.0	70.0	68.0	66.0	53.0	56.0
	100.00	100.0	100.0	100.0	100.0	100.0

Chemical Analyses.

Silica & Insol	96.426	97.215	97.875	97.385	92.493	91.729
Potash (K2O)	0.086	0.157	0.158	0.200	0.169	0.121
Soda (Na2O)	0.247	0.395	0.443	0.438	0.544	0.401
Lime (CaO)	0.054	0.094	0.069	0.049	0.049	0.049
Magnesia (MgO)	0.037	0.028	0.044	0.016	0.080	0.089
Mn. oxide (Mn3 O4)	0.035	0.045	0.135	0.045	0.050	0.095
Ferric oxide (Fe2O3)	0.389	0.350	0.350	0.505	1.127	1.282
Alumina (Al2O3)	0.807	0.870	0.605	0.995	3.658	4.040
Phos. pentoxide (P2O5)	0.050	0.021	0.016	0.011	0.021	0.029
Sulfur trioxide (SO3)	0.077	0.091	0.091	0.060	0.065	0.089
Loss on ignition	1.697	1.134	0.621	0.702	1.361	1.725
Total	99.905	100.400	100.407	100.406	99.617	99.649
Nitrogen	0.066	0.054	0.24	0.024	0.024	0.024

Lime Requirement.

81 lbs.	81 lbs.	75 lbs.	60 lbs.	101 lbs.	169 lbs.

Soil Series III.

Continuing, Mr. Smith writes: "The series was taken from a field that had been farmed only one year, and was located in a low place, and composed of a dark-colored soil, such as is common in the sand-hill region."

Mechanical Analyses.

Laboratory No.	1064	1065	1066	1067	1068	1069
Series III.	Area I.	AreaII.	AreaIII.	AreaIV.	AreaV.	AreaVI.
Greater than 2mm.....	2.0	2.0	3.0	7.0	7.0	7.0
Less than 2 greater than 1...	9.0	14.0	21.0	26.0	17.0	19.0
Less than 1 greater than 1-2..	12.0	14.0	17.0	16.0	14.0	20.0
Less than 1-2.....	77.0	70.0	59.0	51.0	62.0	54.0
	100.00	100.0	100.0	100.0	100.0	100.0

Chemical Analyses.

Silica & Insol.....	95.093	95.410	94.565	93.752	94.264	93.602
Potash (K2O)	0.145	0.186	0.112	0.171	0.089	0.211
Soda (Na2O).....	0.602	0.382	0.687	0.461	0.398	0.425
Lime (CaO)	0.059	0.039	0.069	0.039	0.019	0.024
Magnesia (MgO)	0.049	0.030	0.022	0.018	0.025	0.018
Mn. oxide (Mn3O4)	0.085	0.080	0.050	0.075	0.055	0.140
Ferric oxide (Fe2O3)	0.436	0.389	0.602	0.654	0.602	0.389
Alumina (Al2O3)	1.289	1.284	2.329	2.938	2.593	3.506
Phos. pentoxide (P2O5)	0.021	0.016	0.005	0.009	0.016	0.016
Sulfur trioxide (SO3)	0.045	0.045	0.065	0.036	0.058	0.057
Loss on ignition.....	2.301	1.766	1.877	1.959	1.938	1.774
Total	100.125	99.627	100.383	100.112	100.057	100.126
Nitrogen	0.054	0.042	0.030	0.020	0.018	0.018

Lime Requirement.

112 lbs.	91 lbs.	239 lbs.	299 lbs.	675 lbs.	675 lbs.

Soil Series IV.

"The fourth series of plots came from a field that was under cultivation for the second year."

Laboratory No.	1070	1071	1072	1073	1074
Series IV.	Area I.	AreaII.	AreaIII.	AreaIV.	Area V.
Greater than 2mm.	1.0	1.0	1.0	1.0	2.0
Less than 2 greater than 1...	6.0	10.0	8.0	16.0	17.0
Less than 1 greater than 1-2..	15.0	12.0	16.0	16.0	16.0
Less than 1-2	78.0	77.0	75.0	67.0	65.0
	100.0	100.0	100.0	100.0	100.0

Chemical Analyses.

Silica & Insol	96.303	97.359	97.534	95.657	92.045
Potash (K20)	0.121	0.158	0.109	0.120	0.089
Soda (Na2O)	0.502	0.470	0.350	0.385	0.411
Lime (CaO)	0.074	0.044	0.019	0.039	0.019
Magnesia (MgO)	0.029	0.011	0.041	0.034	0.125
Mn. oxide (Mn3O4)	0.100	0.105	0.100	0.105	0.070
Ferric oxide (Fe2O3)	0.408	0.389	0.408	0.816	1.088
Alumina (Al2O3)	0.399	0.459	0.687	1.791	4.131
Phos. pentioxide (P2O5)	0.024	0.008	0.011	0.019	0.022
Sulfur trioxide (SO3)	0.064	0.053	0.069	0.036	0.043
Loss on ignition	1.942	1.385	0.714	1.138	2.001
Total	99.966	100.441	100.041	100.140	100.044
Nitrogen	0.078	0.042	0.030	0.030	0.021

Lime Requirement.

41 lbs.	61 lbs.	119 lbs.	119 lbs.	202 lbs.

A brief discussion of the chemical analyses in relation to the phosphoric acid, potash, nitrogen and loss on ignition is given below:

Discussion of Chemical Analyses.

Perhaps the most interesting condition noted is the percent-

age composition of phosphoric anhydride in the different sections. They are tabulated below.

	Per Cent. P_2O_5 First 6 inches.	Per Cent. P_2O_5 Second 6 inches.	Per Cent. P_2O_5 Third 6 inches.	Per Cent. P_2O_5 Fourth 6 inches.	Per Cent. P_2O_5 Fifth 6 inches.	Per Cent. P_2O_5 Sixth 6 inches.
Soil Series I..	0.039	0.019	0.011	0.016	0.029	0.032
Soil Series II.	0.050	0.021	0.016	0.011	0.021	0.029
Soil Series III.	0.021	0.016	0.005	0.009	0.016	0.016
Soil Series IV.	0.024	0.008	0.011	0.019	0.022	

From the table given above we note that in every case the first six inches contain the maximum per cent. of phosphoric anhydride, that there is a decrease until the minimum is reached, then there is an increase again as far down as the samples were taken, except in soil series III, in which case the last two areas contain the same. It is further noted that in soil series I and III the minimum is reached in the 12-18 inch area, while in soil series II the minimum is reached in the 18-24 inch area, and that in soil series IV it is reached in the 6-12 inch area. There are two reasons why there should be a higher percentage of phosphoric anhydride in the 0-6 inch samples than in the others. In the first place, all phosphates are soluble to some extent in the soil solution; and as this solution is pulled, by capillary attraction, to the surface the phosphates in solution will be left in the surface soil when the water is evaporated, this would tend to accumulate phosphates in the first six inches. The second cause for this accumulation may be founded on the fact that when we apply soluble phosphates to the soil they are very rapidly reconverted into an insoluble form by the lime and other bases present. Most of the phosphates would be reconverted in the upper areas. We note that soil series I and II have been in cultivation for a long period of years, while types III and IV have only been cultivated one and two years respectively. If the phosphoric anhydride of the first six inches is in any part derived from the reversion of soluble phosphates applied we would expect to find the total higher in soil series I and II than in series III and IV; by consulting the table we find the contents of phosphoric anhydride

for the first six inches of the soils that had long been in cultivation were: Series I, 0.039 per cent. and series II, 0.050 per cent. as against series III, in cultivation for the first year, 0.021 per cent. and series IV, in cultivation for the second year, 0.024. It might be argued that in the case of series III, the greater amount of organic matter might cause a decrease in the percentage composition of the mineral elements, for it contains 2.301 per cent. organic matter, as determined by loss on ignition, as against 1.335 per cent in the case of soil type I "that had been planted for years practically without number," 1.697 per cent. in the case of type II "that had been farmed for perhaps ten years," and 1.942 in the case of type IV which "was under cultivation for the second year." This difference in content of organic matter could not affect any of the results more than one per cent. of the content of phosphoric anhydride, because the greatest difference is 0.966 per cent. and one per cent. of 0.050 per cent., the maximum per cent. of phosphoric anhydride, is 0.0005 per cent of phosphoric anhydride, which is negligible.

The next question that requires explanation is the fact that the content of phosphoric anhydride drops until the minimum is reached, very regularly, and then increases very regularly. There is leaching going on in these soils, for the fact that all phosphates are to a certain extent soluble in the soil water will hold for the gravitational water as well as for the capillary water, therefore we can readily imagine conditions that will cause, first, the rain water to take up carbon dioxide,—which is liberated by the decay of organic matter in the surface soil, and this combination is nature's greatest solvent,—then as this percolates through the lower layers it will absorb salts until it has become saturated, thus decreasing the percentage composition of phosphoric anhydride in the upper areas; but, on the other hand, when seasonal conditions are changed and when the capillary water rises it carries up salts with it, which are deposited in the surface soil when the water is evaporated. Again, when artificial applications of soluble phosphates are made they will be very rapidly reverted, but not necessarily so rapidly that they may not percolate; owing to conditions of moisture and of soil, to a considerable depth, and the 6-12

inch area may in this way have its contest of phosphoric anyhdride made greater than the 12-18 inch area, and the 12-18 inch area greater than the 18-24 inch area, and so on.

The potash content of the different depths shows some interesting relations, although by no means so regular as the phosphoric anhydride content. Below is tabulated the per cent. potassium oxide (K_2O) in each area of each soil series.

	Per Cent. K_2O First 6 inches.	Per Cent. K_2O Second 6 inches.	Per Cent. K_2O Third 6 inches.	Per Cent. K_2O Fourth 6 inches.	Per Cent. K_2O Fifth 6 inches.	Per Cent. K_2O Sixth 6 inches.
Soil Series I..	0.176	0.243	0.149	0.131	0.150	0.195
Soil Series II.	0.086	0.157	0.158	0.200	0.169	0.121
Soil Series III.	0.145	0.186	0.112	0.171	0.089	0.211
Soil Series IV.	0.121	0.158	0.109	0.120	0.089	

An inspection of this table shows that in every series the percent. content of potassium oxide of the 6-12 inch area is greater than the content of the 0-6 inch area. In series I, the increase of the second area over the first is 38.7 per cent., in series II, the increase is 82.6 per cent., while in series III and IV, which have only been in cultivation one and two years respectively and to which very little commercial potash has been added, the per cent. increase is: Series III, 28.3 per cent. and series IV, 30.6 per cent., showing that the potassium oxide is being held in the 6-12 area. In Southern soils the 6-12 inch area is usually compact and there is more clay to form a double salt with, than in the first six inches. The formation of a double salt is the theory usually advanced for the retention of potash salts. The theory for the formation of the double salt of potasium and alumina is that some other base, probably lime is displaced and forms a salt with the acid that was in combination with the potash. If muriate of potash is the salt added, we would expect the formation of chloride of lime, which is a most soluble salt. Now let us turn to the complete analysis of soil series 1,—we find that the lime content of the 0-6 inch area and 12-18 inch area are respectively

0.114 per cent. and 0.104 per cent, while that of the 6-12 inch area is only 0.084, indicating that such a reaction may have taken place and the soluble salt leached out. Mr. Smith states that this series had received "one ton of air slaked lime, which possibly accounts for the higher lime content of the surface area.

It may be argued that this does not hold true for soil type two, but neither do we find that the potash was greatest in the 6-12 inch area, on the other hand, it continues to increase in potash from the 0-6 inch area to the 18-24 inch area, the lime decreasing from the 18-24 inch area.

Turning now to the two series that have been in cultivation but one and two years, we find that the potash content of the 6-12 inch areas are 28.3 per cent and 30.6 per cent. respectively above the 0-6 inch areas content. In the third area there is a decrease in both cases, as would be expected if all of the potash applied as fertilizers was held in the first two acres. In the 18-24 inch area there is an increase over the 12-18 inch area, but in the 24-30 inch areas there is a falling off in both series, this we can only account for by an inequality of the soil.

The nitrogen contents of the series and the areas are tabulated below:

	Per Cent. Nitrogen First 6 inches.	Per Cent. Nitrogen Second 6 inches.	Per Cent. Nitrogen Third 6 inches.	Per Cent. Nitrogen Fourth 6 inches.	Per Cent. Nitrogen Fifth 6 inches.	Per Cent. Nitrogen Sixth. 6 inches
Soil Series I..	0.090	0.060	0.048	0.048	0.048	0.024
Soil Series II.	0.066	0.054	0.024	0.024	0.024	0.024
Soil Series III.	0.054	0.042	0.030	0.024	0.018	0.018
Soil Series IV.	0.078	0.042	0.030	0.030	0.021	

In every case the first six inches contains the highest per cent. of nitrogen. This is to be expected, not only on account of the fertilizers added, but also because most of the organic matter is in this area. There is a gradual decrease in the second and third areas, after which it runs very constant.

The losses on ignition of the series and areas are tabulated below:

	Per Cent. Loss on Ignition. First 6 inches	Per Cent. Loss on Ignition. Second 6 inches.	Per Cent. Loss on Ignition. Third 6 inches.	Per Cent. Loss on Ignition. Fourth 6 inches.	Per Cent. Loss on Ignition. Fifth 6 inches.	Per Cent. Loss on Ignition. Sixth
Soil Series I..	1.335	0.942	0.602	0.934	1.120	1.521
Soil Series II.	1.697	1.134	0.621	0.702	1.361	1.725
Soil Serier III.	2.301	1.766	1.877	1.959	1.938	1.774
Soil Series IV.	1.942	1.385	0.714	1.138	2.001	

	Per Cent. Alumina.	Per Cent. Alumina.	Per Cent. Alumina.	Per Cent. Alumina.	Per Cent. Alumina.	Per Cent. Alumina.
Soil Series I..	0.536	0.715	0.775	2.027	3.123	3.697
Soil Series II.	0.807	0.870	0.605	0.995	3.658	4.040
Soil Series III.	1 289	1.283	2.329	2.938	2.593	3.506
Soil Series IV.	0.399	0.459	0.687	1.791	4.131	

The basis on ignition, a rough determination of organic matter,—shows in these soil series that the content of organic matter is inversely proportional to the length of time that the land has been in cultivation. Series I and II are much lower than series III and IV, notwithstanding the fact that large quantities of organic matter in the forms of barnyard manure and cottonseed respectively had been applied to the two former series.

A close study of this tabulation shows that in every case the loss on ignition decreases in the 6-12 inch area, and in every case except soil series III, which has only been in cultivation one year, there is a further decrease in the 12-18 inch area, after which the tendency is for the loss on ignition to increase. This tendency to increase is very likely due to water of hydration in the clay, mainly in combination with the silicate of alumina present. The percentage composition of alumina is tabulated just beneath the above table and it will be noted that

after the minimum loss on ignition is attained. that the increased loss on ignition runs parallel with an increased percentage composition of alumina in every case except the 30-36 inch area of soil type III.

Clay consists of silica, mixed with silicates of aluminum, calcium, magnesium, potassium, and sodium. These silicates are hydrated so that clay usually contains from 6 to 12 per cent. water in combination. Turning to the complete analyses of these samples we find that the oxide of aluminum is greatly in excess in the lower areas, of the total of the oxides of the other elements mentioned above, they are tabulated for convenience.

Soil Series No.		0-6 inch area.	6-12 inch area.	12-18 inch area.	18-24 inch area	24-30 inch area.	30-3 6nch area.
I.	Per cent. Oxide of aluminum..	0.536	0.715	0.775	2.027	3.123	3.697
	Per cent. Oxides of calcium, magnesium, potasium, and sodium	0.844	0.991	0.801	0.827	0.644	0.818
II.	Per cent. Oxide of aluminum...	0.807	0.870	0.605	0.995	3.658	4.040
	Per cent. Oxides of calcium, magnesium, potassium, and sodium	0.424	0.674	0.714	0.703	0.842	0.660
III.	Per cent. Oxide of aluminum...	1.289	1.284	2.329	2.938	2.593	3.506
	Per cent. Oxides of calcium, magnesium, potassium, and sodium	0.855	0.637	0.890	0.689	0.531	0.678
IV.	Per cent. Oxide of aluminum...	0.399	0.459	0.687	1.791	4.131	
	Per cent. Oxides of calcium, magnesium, potassium, and sodium	0.726	0.683	0.518	0.578	0.644	

Conclusions.—From the foregoing work we are led to believe that in the case of soils of this type,—coastal plain underlain by a sandy clay:

(1) The phosphoric acid applied as soluble phosphate is largely retained in the first 18 inches of soil, and especially in the first six inches.

(2) Much of the potash applied is retained in the second six inches of soil.

(3) The nitrogen content shows highest in the first 6 inches of soil, gradually decreasing to the depth of about 18

inches, below which depth it is low and fairly constant. It must be borne in mind that the location of the nitric nitrogen is affected by seasonal conditions.

(4) The content of organic matter, as determined by loss on ignition, runs inversely proportional to the length of time that the land has been in cultivation.

(5) Where the land has been in cultivation for a number of years, the loss on ignition decreases until the depth of about 18 inches is reached, after which depth there is an increase as far down as the samples were taken.

(6) The above increase is accounted for by the loss of the water of hydration of the clay, mainly in combination with the silicate of aluminum present, at the high temperature employed in determining loss on ignition.

Samples No. 1079-1080 consisting of top soil and subsoil, are from that type of land known as "black jack." They were received from Mr. Wm. J. Chery of Rock Hill, S. C., and came from the farm of Mrs. A. H. Mobley, located about six miles south of Rock Hill, S. C. The analyses follow:

	Sample No. 1079 Top soil.	Sample No. 1080 Subsoil.
Silica and insoluble	76.576	76.290
Potassium oxide (K_2O)	0.191	0.231
Sodium oxide (Na_2O)	0.293	0.279
Lime (CaO)	0.398	0.535
Magnesia (MgO)	0.358	0.377
Maganese oxide (Mn_3O_4)	0.630	0.925
Ferric oxide (Fe_2O_3)	11.742	11.577
Alumina (Al_2O_3)	5.055	5.465
Phosphoric anhydride (P_2O_5)	0.158	0.163
Sulphuric anhydride (SO_3)	0.045	0.062
Loss on ignition	4.295	4.476
Total	99.741	100.380
Nitrogen	0.179	0.093

Both top and subsoil were unusually low in silica and insoluble, and very high in ferric (iron) oxide. The lime content is

unusualy high for South Carolina in both top and subsoil, the same holds true for the total phosphoric acid, nitrogen, and potash. The loss on ignition is rather high, but it may be pointed out that on account of the large percentage of alumina present, much of this loss on ignition, may be accounted for, by loss of water in combination with the silicate of aluminum which may be present in the form of water of combination.

Samples No. 1081-1082 consist of top and subsoil from Mr. A. Goodale, Patrick, Chesterfield Co., S. C.

The analyses are as follows:

	Sample No. 1081 Top soil.	Sample No. 1082 Subsoil.
Silica and insoluble	93.476	92.527
Potassium oxide (K_2O)	0.190	0.204
Sodium oxide (Na_2O)	0.178	0.214
Lime (CaO)	0.215	0.240
Magnesia (MgO)	0.154	0.225
Maganese oxide (Mn_3O_4)	0.325	0.205
Ferric oxide (Fe_2O_3)	0.777	0.544
Alumina (Al_2O_3)	0.903	2.095
Phosphoric anhydride (P_2O_5)	0.116	0.126
Sulphuric anhydride SO_3)	0.055	0.038
Loss on ignition	3.654	3.188
Total	100.043	99.606
Nitrogen	0.177	0.096
Lime requirement calculated as calcium hydrate ($Ca(OH)_2$)	Lbs. 122	Lbs. 753

Samples Nos. 1083, 1084, 1085 and 1086 received from Mr. J. N. Voorhees, Charleston, S. C. Mr Voorhees stated that two of the samples were a soil and subsoil that was very productive while the other two soil and subsoil that was unproductive.

Partial Analyses.	Productive. Top Soil Sample No. 1083	Productive. Subsoil Sample No. 1084	Unproductive. Top Soil Sample No. 1085	Unproductive. Subsoil Sample No. 1086
Potassium oxide (K_2O)	0.163	0.190	0.193	0.216
Lime (CaO)	0.370	0.270	0.250	0.265
Phosphoric anhydride (P_2O_5)	0.126	0.134	0.129	0.126
Nitrogen (N)	0.086	0.078	0.100	0.057
Loss on ignition	1.818	1.284	1.464	2.970
Lime requirement calculated as as calcium hydrate ($Ca(OH)_2$)	Lbs. 122	Lbs. 323	Lbs. 81	Lbs. 3874

Mr. Voorhees states in his correspondence that this land had been unproductive for but one season. The most likely clue to this non-production is the very high degree of acidity of the subsoil of the non-productive sample,—which shows a lime requirement of 3874 lbs. calculated as water slaked lime ($Ca(OH)_2$) and determined according to Hopkin's method. As a further evidence of the effect of acidity in this subsoil we may note the fact that in the case of the productive soil, the top soil showed 0.086 per cent. nitrogen, while the subsoil showed 0.078 per cent. nitrogen; on the other hand, in the case of the non-productive soil, the top soil showed 0.100 per cent. nitrogen while the subsoil showed 0.057 per cent. nitrogen, indicating that the processes of denitrification were proceeding rapidly in this subsoil, which would be expected under this acid condition.

The other miscellaneous analyses were of no general interest, and we do not deem it necessary to discuss them here.

II.—A Continuation of the Sweet Potato Investigation.

This work has consisted of a contimination of the work published in Bulletin 146, it is planned to let this work extend over a period of three years. The laboratory work during 1909-1910 has consisted of the preparation of a number of samples for analysis.

III.—A Comparison of Various Animal Sources of Nitrogen with Nitrate of Soda as a Standard.

This work has consisted of fertilizer analyses a comparison of the availability of the nitrogen present as determined by

the pepsin-hydrochloric acid method with the availability as determined by the neutral permanganate method, and these methods compared with the availability as shown by pot tests using several different crops. It is planned that this work be culminated with a field test, and the entire results published in bulletin form.

IV.—A Study of Basic Slag.

We have underway an investigation of a reaction of basic slag and as soon as this work is completed it will be reported in bulletin form.

V.—A Study of the Causes of the Death of Hogs from Cottonseed Meal Feeding.

During the past year much time has been devoted to the prosecution of this problem, and since a part of the salary of the Station chemist is now derived from the Adams fund, more time will be devoted to this project. We are not yet ready to made a report of the work done, as it is incomplete.

The principal work of the past year was the designing of an apparatus suitable for extracting material. Owing to delay on the part of the manufacturer the apparatus was not received complete until June 18, 1910. Since that time the preparation of the extracts has been in progress. These extracts will be turned over to the Division of Animal Husbandry, with which we are in co-operation, for feeding.

VI.—*Co-operative Work.*

During the past year the entomologist and the chemist have been associated in co-operative work with some farmers in Colleton County. The entomologist, in making a study of the wire-worm, which is proving so disastrous to the agriculture of that section, requested the chemist to aid him in the work by attending to the fertilizing in connection with certain experimental plots,—the object being to hasten the crops by fertilization and in this way get it far enough advanced to withstand the ravages of the worms before they began their destructive work. Several formulae were planned by the chemist and he superintended in person the mixing and application of the fertilizers. His plan was to carry on a comparison of acid phosphate (16 per cent.) with basic slag (18

per cent.) at the same time. He further planned to add the same amount of lime to some of the acid phosphate plots as was carried by the basic slag in order to ascertain whether the effect of the slag is due to the phosphorous or the lime that it contains. The lime did not arrive in time, but at his request, Mr. W. C. Brant, one of the co-operators put some oyster shell lime on one of the cotton plots. This was the only one of the cotton plots that gave a good stand; from this the possibility suggested itself to us that perhaps there is some connection between the acidity of the soil and wire-worn activity. A plot on which stable manure was used in connection with commercial fertilizers was also included in the fertilizer work. On this plot a most excellent crop of corn was grown,—far better than on any other plot, which shows the great need of this type of soil for organic matter.

The chemist assisted the referee of the Association of Official Agricultural Chemists in the work on soils.

Publication: Bulletin No. 151, "Soils and Fertilizers."

Respectfully submitted,

T. E. KEITT,
Chemist.

REPORT OF SECRETARY AND LIBRARIAN.

Clemson College, S. C., Oct. 14, 1910.

Prof. J. N. Harper, Director, S. C. Agricultural Experiment Station.

Dear Sir: Complying with your instructions, I beg to submit the following report of some of the work performed in the office of the secretary and librarian of the South Carolina Experiment Station, embracing the period of the fiscal year, beginning July 1st, 1909 and ending June 30th, 1910.

The agricultural public of South Carolina still continues to exhibit an increasing appreciation of the publications of the South Carolina Experiment Station distributed under the supervision of the secretary. This has been clearly demonstrated by the fact that during the year recently closed, 1,300 representative farmers applied to have their names enrolled on the permanent mailing list in order that they may receive the publications of this office as they may be distributed in the future.

The activity and success of this office in placing the results of the Station's work before its large constituency of farmers, continue with unabated zeal, as the work becomes more significant and indispensible to their present and future improvement. Nothing so readily gives practical value to the work of the Experiment Station as an extended dissemination of the reports of its progress and final accomplishment, in the solution of agricultural problems.

During the fiscal year just passed, this Station has issued six bulletins and one annual report. These contain in the aggregate 255 pages and were distributed in an edition of 93,000 copies. These include scientific discussions of "Hybrid Cottons," "Fall and Winter Cabbages," "Farm Management for Controlling Field Crop Insects," "Soils and Fertilizers," "Hog Cholera and the Serum Method of Treatment," and "Notes on Varieties of Tomatoes and their Diseases."

In addition to the above, the work of sending out to the farmers of the State, the analyses of commercial fertilizers, was begun in the month of January. A leaflet of four pages containing these analyses was published at the College and mailed from this office once a week for twenty-nine consecutive weeks in editions of 14,000 each. This was a guarantee of safety to the farmers of the State against the purchase of fraudulent fertilizers.

The total number of bulletins issued from this Station during the past fiscal year, including the fertilizer leaflets, amounted to 499,000, approximately a half million copies.

The library of the Experiment Station receives careful attention, and as a result it is growing in magnitude, interest and general importance.

Respectfully submitted,

JNO. N. HOOK,

Secretary and Librarian.

REPORT OF VETERINARIAN AND ANIMAL HUSBANDMAN.

Clemson College, S. C., Oct. 21, 1910.

Prof. J. N. Harper, Director, S. C. Experiment Station.

Dear Sir:

The work of this Division during the past year has been mainly a continuation of the experiments in progress during the previous year.

The study of the physiological effects of feeding large amounts of cotton seed meal to dairy cattle has been continued and almost completed with the result that our previous conclusions have been confirmed, viz., that fed in amounts from 6 to 8 lbs. daily per animal for long periods—1 to 3 years—it has resulted in lessened production, udder troubles, such as mammitis and abortion. In a few cases so fed, there has been a marked falling off in condition, as shown by steady loss in weight each month,—one case particularly becoming much emaciated, but curiously enough, while still continuing the same amount of meal these animals have gained in weight again recently. This may be due to a difference in the samples of meal fed and again suggests the idea that different samples vary in their toxicity.

As no animals have died from the effects of cotton seed meal, there has been no work done pathologically, but it is planned to kill at least three of them for beef in the near future and study the internal organs for pathological lesions, these being three that have been fed large amounts for the past three years and have at times been very unthrifty.

The results of the past three years' work on this project are now being prepared for publication and will shortly be issued in bulletin form. It may be said, however, that cotton seed meal may be safely used as the basis for the concentrated portion of the ration for dairy cattle, the amount of 4 lbs. daily for mature cattle appearing to give the best results when fed with corn meal or dried beet pulp and brain, using ensilage ad libitum for roughage.

Owing to the fact that a longer time was necessary than was at first expected in the preparation of extracts of cotton seed meal by the Station chemist, the work planned co-operatively with the Division of Chemistry has not progressed to the actual feeding of animals with these extracts, but a sufficient quantity is now on hand to insure the commencement of feeding operations in the near future.

As mentioned in a previous report, the problem of determining just what connection the amount of cotton seed meal fed has to such troubles as abortion in dairy cattle, has been somewhat difficult by the fact that when this problem was taken up all of the cattle had been fed to some extent with cotton seed meal and it was therefore impossible to determine in certain cases where the amount of meal was cut down, whether abortion might not be due to the injurious effects of the previous heavy feeding. We have, however, obtained eight Jersey heifers that have not been fed cotton seed meal in any amount and we are expecting that observations on these will throw more definite light on this subject.

In attempt to demonstrate the possibilities for profit in dairying in this State, and to show the cost per year for keep of a dairy cow here, the records of seventeen cows in the dairy herd have been carefully collected and are here given. This record includes the work only of cows of strictly dairy type, animals of the beef breed in the Station herd not having been included. It should also be borne in mind that a number of the cows included, owing to other experimental work being done with them, have not made as good a showing as they are capable of but the results serve to show in a general way the possibilities in this business.

The cows considered here include 13 Jerseys, 3 Ayrshires and 1 Grade Jersey, and the average amount of milk per cow for the year was 5,741 lbs., averaging 4.5 per cent butter fat. This milk, easily worth 20 cents per gallon at the farm, would amount to $133.50 per cow.

The actual average cost of feed for these cows was $57.23 per cow, leaving a profit above cost of feed of $73.27 per cow. The feed was bought at the following prices:

Cotton seed meal	$30.00 per ton
Bran	28.00 per ton
Corn meal	35.00 per ton
Oil meal	35.00 per ton
Dried beet pulp	29.00 per ton

The price for beet pulp is relatively high as only a small shipment was bought, and the actual cost is charged up here, though it could have been bought by the car load for $26.00

per ton. Five dollars per head was charged for pasture, which is probably high as the pasture was very poor and ensilage was fed nearly the whole year round, the ensilage being charged at $3.00 per ton.

It will be noticed that in figuring the annual profit per cow at $73.27 nothing has been charged for labor, but on the other hand, nothing has been credited to the manure produced. Based on the price of commercial fertilizers, the value of this manure would be not less than $2.00 per cow, which would readily cover the item of labor. The calves obtained would materially lessen the depreciation in value of the cows and there would also remain as an expense item the interest on the capital invested in the herd and barn. It is safe, however, to say that after all expenses have been allowed for a yearly profit of $50 per cow can readily be made.

The record shown scarcely gives a fair representation of the possibilities in dairying for reasons above mentioned, but it is given with the hope that it may stimulate to some extent the dairy industry.

Further details of this work including the exact amount and kind of feed used, will be published later.

An experiment was conducted to determine the relative values of corn meal and dried beet pulp when fed to dairy cattle receiving 4 lbs. of cotton seed meal daily. The high price of corn in this section makes it necessary to substitute a cheaper carbohydrate feed, and the results of this experiment, in which ten cows were used for an average feeding period of 177 days, indicate that dried beet pulp is a much more economical dairy feed than corn meal. The results of this experiment are given in detail in another part of this report.

In the investigation of the stomach worm and hook worm disease in young cattle and lambs, the work during the past year has been mainly confined to clinical observations, the young cattle of the College herd having shown little evidence of the disease, no cases whatever dying from it. This is no doubt due to the fact that they have been removed to upland pastures. It is note-worthy that a part of this upland pasture was infested during the fall of 1908, the young cattle having had the run of both upland and bottom land the previous year

and it will be remembered that a death rate of 27 per cent. was obtained on the upland, as against 66 per cent. on the lowland pastures. The fact that no cases have shown up during the fall of 1909 would indicate that, when facilities for reinfesting the upland from the lowland pastures were avoided, the death rate fell from 27 per cent. to zero in one year, and this further verifies our belief that the most practical method of dealing with this disease is to avoid such lowland pastures for youngcattle, especially as such pastures can be safely used for mature cattle. Early in the summer of 1909 a number of lambs were placed on a pasture known to have been infested with stomach worms two years previous, with the object of determining whether such pasture was still capable of conveying the disease. This pasture was for the most part upland, but had a narrow strip of creek bottom running through it and nothing but mature cattle had access to it for two years, and these only very occasionally.

Up to the present time this year no symptoms of the disease have been noticed, and in two cases dying from other causes, only about half a dozen stomach worms were found. These sheep will, however, be slaughtered shortly and a careful examination made for any parasites or evidences of disease. Owing to the fact that there has been such a scarcity of infested material at hand, the work planned on the study of the blood in this disease and experimental inoculation has not been carried out, but it is expected that material will be obtained in sufficient quantities from outbreaks in other sections of the State to carry on this work.

The work of immunizing hogs against hog cholera has been continued with gratifying results so far as the efficiency of the serum is concerned, and these results were published in Bulletin No. 152. One of the difficulties in the way of a wider field of usefulness for this method in this State is the fact that in sections where the disease is most prevalent many of the herds have the run of large swampy pastures which are more or less infested all the time, the animals at any given time on such pastures being mostly immune. The gradual loss of a considerable percentage of the young pigs on such farms does not

attract the attention of the farmer as in cases where cholera breaks out among a herd of non-immunes.

It is, however, planned to do some demonstration work where conditions justify such work and eventually to place the serum in the hands of the veterinarians and hog raisers of the State. In the development of the immunizing serum attention is being particularly directed towards cheapening the production.

The small herd of Berkshire hogs has been increased and now contains six sows and one boar, and observations are being made on the cost of keeping such a breeding herd with different feeds, nothing however, being ready for publication at this time. We have been fortunate in obtaining what is considered by many good judges as the best Berkshire boar in the South, together with some choice sows, and pigs for breeding purposes are being sold at a reasonable price to the farmers of the this breed in the State, the Berkshire being admittedly one of the best breeds for this section.

During the summer, a number of Farmer's Institutes were attended and a general talk on the advantages of live stock to the farmer was given, particular stress being laid on the fact that dairying is the most profitable branch of the live stock industry for most farmers, closely followed by the hog raising industry.

Considerable correspondence has been handled during the year, probably most of which has been on questions relative to hog raising, a subject which is receiving much more attention from the farmers of the State than ever before.

Respectfully submitted,

E. BARNETT,

Veterinarian & Animal Husbandman.

OF THE
UNIVERSITY OF ILLINOIS
23 APR 1915

TWENTY-FOURTH ANNUAL REPORT

OF THE

South Carolina Experiment Station

OF THE

Clemson Agricultural College

FOR THE YEAR ENDING

JUNE 30, 1911

Anderson, S. C.
Oulla & Morrow, Printers
1911

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MISS HELEN BRADFORD, *Stenographer.*

Mail and Telegraph: Clemson, S. C.

Freight and Express: Calhoun, S. C.

The Bulletins of the Station are issued at irregular intervals, and sent free to all citizens of the State who apply for them.

LETTERS OF TRANSMITTAL.

Clemson College, S. C., December 1, 1911.

Hon. Alan Johnstone, President Board of Trustees, The Clemson Agricultural College.

Dear Sir: I beg to submit herewith the Twenty-Fourth Annual Report of the South Carolina Agricultural Experiment Station, which in accordance with the law, must be submitted to the Governor on or before February 1, 1912.

Yours very truly,

W. M. RIGGS,
President.

Clemson College, S. C., December 1, 1911.

Hon. Coleman L. Blease, Governor of South Carolina.

Sir: I have the honor to submit herewith the Twenty-Fourth Annual Report of the South Carolina Experiment Station, in accordance with the requirements of an Act of Congress, approved March 2, 1887, for the establishment of Agricultural Experiment Stations in connection with the colleges of the several States, organized under the provisions of an Act approved July 2, 1862.

Respectfully submitted,

ALAN JOHNSTONE,
President Board of Trustees.

ANNUAL REPORT OF DIRECTOR OF SOUTH CAROLINA EXPERIMENT STATION.

Clemson College, S. C., Nov. 6, 1911.

Dr. W. M. Riggs, President, Clemson College.

Dear Sir: I have the honor of submitting herewith a brief report of the work of the South Carolina Experiment Station for the fiscal year ending June 30, 1911.

Most of the experiments now under way are continuations of those planned a few years ago.

The Station officers continue to have thousands of letters from farmers of the State asking detailed advice on nearly every subject connected with agriculture. This giving to the farmers at first hand the results of experiments conducted at our Station and elsewhere is one of the important features of our experimental work. That the information that we give in these lettets is valued is evidenced by hundreds of letters received from farmers expressing their appreciation.

During the year nearly every member of the Station Staff has given assistance to the superintendent of the Extension Division in making addresses at various agricultural meetings held in different parts of the State.

The Station made an exhibit at the State Fair which was viewed by thousands of people who took great interest in the exhibit which was of educational value.

The Station continues to co-operate with the Department of Agriculture in a number of experiments, such as the testing of forage plants and leguminous crops in different sections of the State, and in working out the life history of some of the most injurious cotton and corn insects; in making a plant disease survey of the State; in developing immune varieties of cotton to resist the cotton wilt disease.

The mailing list of the Station is constantly growing. We have now about 18,000 names of farmers on our mailing list who receive all of the publications issued by the Station.

Some of the most important problems now being investigated are as follows:

Experiments to determine the fertilizer requirements of upland soils of South Carolina for the various staple crops when grown in a number of different rotations. We have accumulated valuable data covering a period of about six years. We have found that potash, except in small quantities, is not needed for the staple crops in the Piedmont section. Corn requires more potash than does cotton. In our rotation experiments we have found that a two-year rotation, that is, cotton with a winter cover crop, followed by corn with peas, is as effective in building up the soil as a three or four-year rotation.

We have continued our experiments in developing new types of cotton. This breeding work has been along two lines: (1) To develop a high yielding, big boll variety: (2) to develop a long staple high yielding variety. Our long staple variety that we have developed at this College outyields all of the other long staple varieties grown in the State. It will now be our object to establish this variety and get as much of the seed grown as possible to be distributed to the farmers. To make comparisons, we have about fifty of the standard varieties of cotton under test. Our breeding work also includes selection for increasing yield, length and quality of fiber and the size of the boll, and general vigor of the plant. We have a number of varieties of cotton growing in practically every county of the State, and we find that the different types of soil require different varieties of cotton, as some varieties of cotton are better adapted to one type of soil than to others.

We have continued our breeding work with corn and have been successful in increasing the uniformity of the ear and increasing the yield of grain. We have developed a splendid variety for ensilage. We have three other varieties that give splendid yields and will be in position to distribute several hundred bushels of corn throughout the State next spring.

Our experiments with fertilizers containing various sources of amonia are being continued. A report on these will be made next spring.

During the past year we have accumulated data that showed that oats and wheat should be well fertilized in the fall and should receive no other fertilizers in the spring except a top dressing of nitrate of soda. Where we applied the same amount of fertilizer in the spring as in the fall we got only half the increase from check as we did from plots receiving full application of fertilizer in the fall.

We have completed five years' tests with various cover crops, and find that vetch and rye are the best. Vetch and rye should be turned under early in the spring when the ground is in good condition for plowing.

In our experiments to determine the best grass to be used in holding terraced banks, we find that the Texas blue grass is best for this purpose on terraces with northern exposure, and Bermuda the best grass when the exposure is southern.

We have just completed a four years' test of acid phosphate in comparison with floats, and these tests show that acid phosphate gives far better results than floats.

For four years the Station has conducted experiments to determine the effect of pollen from barren stalks on the yield of corn. While we do not find that the corn decreases in yield from year to year, we do find that the pollen from the barren stalks affects the position of the ear on the stalk.

The Station is conducting elaborate experiments with grape culture, especially with the Rotundifolia type. These experiments cover methods of pruning, training the vines, and breeding new varieties, also the testing of about 125 varieties of bunch grapes.

The experiments with asparagus have been most interesting. The male plants of asparagus produce 50 per cent. more stalks than do the female plants. The male plants also appear to be more resistant to rust.

The new variety of okra developed by Prof. Newman has been scattered broadcast throughout the State, and it is considered the best variety ever planted.

The Station continues work in trying to devise means of combatting pear blight. No definite remedy has been discovered, but the work thus far is promising.

The horticultural experiments cover a broad field, such

as experiments with apples, peaches, and with a great variety of vegetables.

The work along the line of plant diseases has been of a high order. Prof. Barre has continued his anthracnose investigations, and he has found that this dreaded disease can be easily eradicated in one season by careful methods of selection. Prof. Barre has devoted most of the year to the investigation of this disease, and in devising methods of keeping sweet potatoes. He finds that the rot of sweet potatoes is due largely to various bacteria and fungus diseases that with little care can be avoided.

The Station work along entomological lines has been confined largely to the cotton and corn root louse and corn wire-worm. These insects cause considerable damage in the State. Prof. Conradi has an assistant in Marion County devoting all of his time to the study of the life history and methods of control of these insects. During the year Prof. Conradi has conducted experiments in Colleton County in working out the life history of the cotton wire-worm, and he has run experiments in rotation, using repellents and cultural methods, There have been a number of miscellaneous insect outbreaks throughout the State. such as red spider and pine bark beetle, and these insects are receiving the attention of Prof. Conradi. He has co-operated with a great number of farmers in spraying their orchards, groves and shade trees, and a great deal of useful information has been given out by this method. His experiments in the State have saved thousands of dollars to the fruit growers during the last year.

The chemist of the Station has obtained valuable data with the different forms of nitrogenous manures. He is also getting along splendidly with his work in determining the the cause of cotton seed meal poisoning. The Chemical Division has about completed the work in which the Station has been engaged with the sweet potato. A full report of the sweet potato investigations will be issued soon as a bulletin. Prof. Keitt's investigation of the phosphoric acid content of soil has been the most complete work on this subject that has been done in the South. Prof. Keitt has made a great num-

ber of miscellaneous analyses of soils, etc., during the past year.

The Animal Husbandry Division of the Station has continued its study of the physiological effect of feeding large amounts of cotton seed meal to dairy cattle. These experiments show conclusively that when dairy cattle are fed from 6 to 8 pounds daily of cotton seed meal, through long periods, that udder trouble and other physiological disturbances take place which are more or less injurious to the cow. The Station has built up a splendid herd of Berkshire hogs, and we now have a first class Jersey herd, although small.

The following are some of the most important projects under the Adams Act being prosecuted by the Station :

Investigation of the parasites of the intestinal tracts of ruminants.

Experiments to determine the relation of temperature to insect activity.

The cause and dissemination of contagious abortion in cattle.

Physiological and pathological effects of feeding large amounts of cotton seed meal to cows.

Experiments to determine the cause of cotton seed meal poisoning in hogs.

A study to determine the relation that exists between soil types and the length of the fiber of cotton.

Experiments to determine the effect of foreign pollen on the productiveness of the varieties of Rotundifolia grapes.

A study of the life history of the fungus which causes anthracnose in cotton.

Experiments to determine the relation that exists between the moisture evaporated by plants and the amount of nitrates in the soil.

Experiments to determine the various factors affecting the composition of cotton seed with special reference to content, location in the seed, and the form of phosphoric acid on upland varieties of cotton.

Experiments to determine the influence of environment on heredity.

Experiments to determine the influence of excessively rich carbohydrate ration on the fecundity of sows.

Experiments to determine the cause of the shedding of cotton.

Experiments to determine the cause of the partial insolubility in water of potash salts when mixed with basic slag.

The work of the Coast Station during the past year has progressed most satisfactorily. We have completed the drainage of more than 100 acres and during the past year we had growing on this formerly wet, swampy land, magnificent crops. The yield of cotton was more than one bale per acre; the oat yield more than fifty bushels; and the corn yield averaged fifty bushels. The drainage system is working perfectly and the health of the employees has been good. Large yields of hay and forage crops have been obtained. We are now conducting experiments with various grasses, forage crops, fruits, vegetables, and a great number of fertilizer tests.

The Station officers are conducting several hundred experiments with farmers in the State in determining the fertilizer requirements of cotton on different types of soil, fertilizer experiments with corn, tobacco, oats, rotation experiments and variety tests of cotton, corn, sorghum, clover, cowpeas, wheat, sweet potatoes, millet, Irish potatoes, Kaffir corn, and various grasses.

Very truly yours,
(Signed) J. N. HARPER,
Director.

SOUTH CAROLINA AGRICULTURAL EXPERIMENT STATION, IN ACCOUNT WITH THE UNITED STATES APPROPRIATIONS, 1910-1911.

Debtor	Hatch Fund	Adams Fund
To balance from appropriations for 1909-1910		
Receipts from the Treasurer of the United States, as per appropriations for fiscal year ended June 30, 1911, under		

		Hatch Fund	Adams Fund
acts of Congress approved March 2, 1887 (Hatch Fund), and March 16, 1906 (Adams Fund)		$15,000.00	$14,900.00
Credit	Abstract		
By Salaries	1	8,033.33	7,266.67
Labor	2	2,292.50	2,967.91
Publications	3	786.58	.....
Postage and stationery	4	171.34	121.72
Freight and express	5	184.15	47.34
Heat, light, water and power	6	65.48	66.94
Chemicals and laboratory supplies	7	188.53	270.48
Seeds, plants and sundry supplies	8	385.37	354.52
Fertilizers	9	370.11	341.12
Feeding stuffs	10	756.75	822.89
Library	11	223.89	401.79
Tools, machinery and appliances	12	250.22	289.32
Furniture and fixtures	13	183.02	8.00
Scientific apparatus and specimens	14	6.85	185.59
Live stock	15	304.00	1,300.52
Traveling expenses	16	249.87	150.55
Contingent expenses	17	2.00	.....
Buildings and land	18	546.01	304.64
Balance		.....	.....
Total		$15,000.00	$14,900.00

We, the undersigned, duly appointed Auditors of the Corporation, do hereby certify that we have examined the books and accounts of the Treasurer, South Carolina Experiment Station for the fiscal year ended June 30, 1911; that we have found the same well kept and classified as above; that the balance brought forward from the preceding year was $..... on the Hatch Fund and $..... on the Adams Fund; that the receipts for the year from the Treasurer of the United States were $15,000 under the act of Congress of March 2, 1887, and $14,900: for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving balances of $..... and $.....

And we further certify that the expenditures have been solely for the purposes set forth in the acts of Congress ap-

proved March 2, 1887, and March 16, 1906, and in accordance with the terms of said acts, respectively.

(Signed)

R. W. Simpson,
Chairman Finance Committee,
M. L. Donaldson,
} Auditors.

Attest: P. H. E. Sloan, Custodian.

SOUTH CAROLINA AGRICULTURAL EXPERIMENT STATION, 1910-1911.

(Supplementary Statement.)

(This supplementary statement, while not required by law, is desired as an aid in interpreting the account rendered for the United States appropriation. While it will be more useful if made in conformity with the schedule fixed for that appropriation, if this is not practicable such a summary of receipt and expenditures from the sources indicated below as can be conveniently prepared from the books of the Station may be substituted. Whenever practicable it should be for the fiscal year ended June 30.)

Debtor		
To balance on hand	$4,236.67	
Receipts from other sources than the United States for the year ended June 30, 1911	2,909.40	$7,146.07

Credit		
By Salaries	$	
Labor	448.61	
Publications	897.88	
Postage and Stationery	29.62	
Freight and express	116.95	
Heat, light, water and power	41.45	
Chemicals and laboratory supplies	30.77	
Seeds, plants and sundry supplies	251.16	
Fertilizers	242.03	
Feeding stuffs		
Library	3.27	
Tools, machinery and appliances	148.47	
Furniture and fixtures		

Scientific apparatus and specimens.....		
Live stock.....		
Traveling expenses.....	153.56	
Contingent expenses.....	44.75	
Buildings and land.....	35.98	$2,444.50
Balance.....		$4,701.57

REPORT OF HORTICULTURIST.

Clemson College, S. C., Nov. 25, 1911.

Prof. J. N. Harper, Director, S. C. Experiment Station.

Dear Sir: I herewith submit the annual report of the Horticultural Division of the South Carolina Experiment Station for the year ending June 30, 1911.

The work of this division has progressed very satisfactorily during the past year. Practically all of the experiments reported in last year's annual report have been continued, and some new projects begun. The work of the Coast Station is now well under way, and many experiments with truck crops especially adapted to that section have been begun.

Asparagus Experiments.—Our experiments in breeding asparagus in order to secure varieties immune to rust have been continued. The experiments in comparing the yield of male and female plants have also been continued. The record for the past season shows that the male plants have produced at least one-third more edible stalks than the female. Another advantage in growing the male plants is that no seedling asparagus plants come up in the field, while in a field of female plants the seedlings become troublesome weeds. In the asparagus nursery this season we have found that we can easily determine the male from the female plants the first season from seed. Where the plants were thinned out to five inches apart in the row, 90 per cent. of them produced flowers in the late summer. Where the plants were not thinned out but allowed to grow thickly in the rows, very few plants produced blossoms the first year. The male flowers being fully twice as large as the female, it is very easy to determine one from the other at a glance. If there is any doubt as to

whether a plant is male or female, it is very easy to determine the difference accurately by a careful examination of the flowers with a hand microscope. The male flower has no pistil, while the female has no stamens. As the asparagus seedlings bloom late in the summer, they frequently do not form seed and it is therefore necessary to select the male plants before the tops are killed by frost, otherwise it would be impossible to determine one from the other. If the plants are allowed to remain in the nursery row for two seasons, then the male plants can be easily determined, as all the female plants will be covered with red capsules containing seed, while none will be found on the male plants. One year old asparagus seedlings grown in the South are much larger than one year old Northern grown plants. This is due to the fact that our growing season is several months longer than the growing season in the North. Our experiments show that one year old asparagus seedlings grow off much better than two year old plants. At the end of the second year's growth the plants are so large that the check in transplanting is considerable. We, therefore, recommend the planting of one year old plants. The results of these experiments will be published as soon as the records can be completed. Our fertilizer experiments with asparagus will be continued.

Okra.—Our breeeding experiments with okra will be continued another year. We have now on hand a large quantity of seed from a very prolific variety which we have obtained from breeding and careful selection over a long period of years, These seed will be distributed over the State this win. ter and next spring. Our experiments in pruning okra have also been continued and the results continue to be greatly in favor of the pruned plants, the yield per acre being much greater than where the plants were not pruned.

Lettuce.—Our experiments in growing fall and winter lettuce in the open ground have been continued, our object being to determine just what time the seed should be planted in the fall in order that the plants may become well established before cold weather and yet form heads before spring. Our experiments show that lettuce seed planted in this section of the State between September 1 and October 15th, make con-

siderable growth before cold weather, and sometimes form small heads but not large enough for table use. In the spring when these plants begin to grow they immediately run to seed and are therefore of no value. When the seed are planted about November 1 the plants make very little growth before freezing weather, but stand the winter without being seriously injured by the cold. As soon as spring opens up the plants grow off readily and form large, compact heads, which will be ready for market at least six weeks before plants can be had from seed sown in the spring.

Similar experiments along this same line have been carried on with beets, cabbage and onions.

Onions.—Our experiments to determine the proper date for sowing onion seed in the field have been continued and our results along this line have been very gratifying. Onion seed sown early in September in the field frequently produce bulbs of considerable size before very cold weather. After the first severe freeze, the plants remain in a comparatively dormant condition until the warm weather of spring. They then grow off rapidly and those plants which form bulbs in the fall will run to seed immediately without the bulb growing any larger. Onion seeds sown in the open ground from the 15th of October to the 1st of November make very little growth during the fall and early winter and are killed to the ground by the first severe freeze. In the early spring, however, the small plants grow off rapidly and produce large bulbs, maturing between April 15th and May 30th. The practice of growing onions from seed in hot beds and then transplanting to the field in the early spring is not to be recommended in the South. It is very expensive to transplant the young onions, and nothing is to be gained by it when the seed can be sown in the open ground and held over during the winter without injury from cold. We find that when the onion seed are sown in the field we are not troubled with grass or weeds to any extent as we have frost about the middle of October which kills most of the troublesome grasses and weeds. This, in itself, is a great point in favor of sowing the seed in the fall rather than spring. The onions will become well established in the spring before the grass and weeds appear and may be cultivated easily with

the wheel plows. This does away with the expensive hand work which is always necessary when the seeds are sown in the spring. Our experiments along this line will be duplicated at the Coast Experiment Station.

Rotundifolia Grapes.—Our breeding and pruning experiments with the Rotundifolia grapes have also been continued. During the last season although our results in crossing varieties of these grapes were very satisfactory, and we were very much disappointed by having the grapes stolen before they reached maturity, which resulted in almost a total loss of our work. The breeding experiments will be continued another season in a more remote section with the hope that the fruit will not be destroyed. The vines which we used last year were in a very public place, and the grapes were taken as fast as they ripened. Our pruning experiments were continued and the results published in Bulletin No. 132, verified. No new light has been thrown on this subject.

Grapes.—We have also conducted experiments in breeding new varieties of grapes. This work will also be continued. This season we fruited ninety-three varieties of grapes, many of them being new varieties that have not before been tested in our trial grounds. The following new varieties give promise of being exceedingly profitable for our State: Armalaga, Lucile, Last Rose and Du Tarque. The last named variety is a seedling of Brighton, originated by Mr. J. K. Young of Union, S. C. This is probably the most promising of all new grapes tested during the past few years.

Our experiments with pollenizing the Lindley grape in order to make the bunches more compact, have been very encouraging. The past season, Lindley pollenized by Concord, produced bunches which were very compact indeed, in fact, so compact that one would not recognize them as the Lindley. This was first done by hand and later vines of Concord were planted adjacent to the Lindley and the branches intermingled. In this way the Lindley was well pollenized by the Concord pollen and the grapes set remarkably well. These experiments will be continued with other varieties.

Citrus Trifoliata.—Owing to the great interest which is being taken in this plant for hedge purposes, and owing to

the fact that they are very difficult ordinarily to grow from seed, we determined to conduct experiments in handling these seeds before planting. It seems to be necessary that these seed be stratified in sand in the early fall and kept in a cool, moist place during the winter and planted to the open ground between the first and fifteenth of April. Seed kept dry throughout the winter and then planted in the early spring will never give good results, and as a rule 75 to 90 per cent. of them will not germinate. In order to stratify the seed, first place one inch of moist sand in a box ; then spread the seed over the sand in a thin layer and cover with half an inch of sand. Then place another layer of seed, and continue this until all the seed have been stratified. The sand box should then be covered with moist bagging or spagnum moss in order to prevent its drying out. The box of seed should be stored in a cool place where the temperature will not drop below 30 degrees. In the spring the seed should be watched very carefully and as soon as they begin to sprout they should be planted immediately. The rows should be 18 inches apart and the seed planted 3 inches deep and very thick in the row. In a block of Citrus seedlings grown in the experiment grounds last season, we produced at the rate of 205,000 per acre. These plants average 18 inches high. This plant is now being used very extensively for hedge purposes. After four years, it makes an exceedingly strong hedge that will turn stock of any kind. It should be pruned at least once each season in order to make it compact, It does not produce suckers from the roots like the Osage orange, and is therefore not objectionable on that account. When once established it makes a permanent screen or fence which will turn either man or beast.

Pears.—Our experiments to control pear blight by cultural methods have been continued. These experiments are to run over a period of ten years, The orchard now has just finished its third years' growth, and as yet no blight has appeared on any of the trees. Next season the trees will bloom freely and the probabilities are that by another year some interesting results may be expected. The variety orchard is

now of bearing age, the trees are free from blight and otherwise in good condition.

Peaches.—Our variety peach orchard has made good growth and the prospects for a good crop the coming season are very good. Our experiments in growing peaches on the northern, eastern and western slopes will be continued, and the coming season will very probably show some effects of the frost on the blossoms of the trees planted on these different exposures.

Apples.—Our breeding experiments with apples have been continued. The variety orchard, which is composed largely of seeding apples originating in the South, has made very satisfactory growth, and a great many of the trees will bloom next season. Only a few of these varieties have been tested in this section before, most of them originated in the Blue Ridge Mountains and should be well adapted to this section of the State.

Persimmons.—We have continued to collect scions of promising native persimmons, and have now quite a collection of varieties which ripen from the last of August to the first of December. Many of these varieties are large, trees very productive and the fruit of excellent quality. Two of the varieties ripen their fruit in November but hold on the trees well until late in winter. These two varieties seem to be especially valuable. They will be propagated and tested in several sections of the State. The majority of the Japanese persimmons were killed to the ground by cold in October, 1910. Most of them, however, have produced sprouts from the scion and have made a very nice growth this season. The indications are that only a few of the standard varieties of Japanese persimmons will be hardy here.

Work at Coast Station.—Our experiments at the Coast Station with all of the fruits and vegetables which seem to be well adapted to that section of the State will be continued. After these fruits and vegetables have been tested in a small way, they will be planted more extensively, but the first point

is to determine just what varieties and types are best adapted to the soil and climatic conditions of that section.

Respectfully submitted,

C. C. NEWMAN,

Horticulturist.

REPORT OF BOTANIST AND PLANT PATHOLOGIST.

Clemson College, S. C., November 22, 1911.

Prof. J. N. Harper, Director, Clemson College, S. C.:

Dear Sir: I respectfully submit the following report of the Botanical Division of the Experiment Station for the fiscal year ending June 30, 1911. During the year the lines of investigation previously reported have been continued. In addition to these several new projects have been taken up. A summary of each phase of the work is given below:

Cotton Anthracnose.

The work with cotton anthracnose has been continued during the year and a report of the progress made with some of the important phases of the investigation is appended hereto as a separate article. It will be seen from the article that practically all of the points brought out earlier than in the investigation have been substantiated by further investigations. The new points brought out in this year's work are as follows: The fungus which causes the disease does not seem to live for more than four or five months in the old diseased bolls and seed which are buried in the soil, but will remain alive for twelve months in bolls on stalks left standing in the field. This emphasizes the necessity of plowing the stalks under as soon as the cotton is picked in the fall.

The spores and filaments of the fungus remain alive on the outside of the seed eight to nine months, long enough to cause disease on the seedlings when they come up in the spring. This indicates that it is not safe to gin cotton for seed on the same gin immediately aftar diseased cotton.

Open locks in diseased bolls contain diseased seed.

Plants grown from seed from such locks showed an abundance of disease both on the seedlings and on bolls of the mature plants.

A method has been devised by which it is possible to detect the disease in the seed and to determine the per cent of the seed of any given samples which carry the disease. This will enable us to to test any sample of cotton seed and tell whether it is diseased with anthracnose.

The breeding work for disease resistance is being continued but is not in shape now for publication. The season's results give further evidence that the diseased can be eradicated in one year by seed selection and erop rotation.

Sweet Potato Rots.

So much of our time has been taken up with the cotton disease investigations that there has been little opportunity to push the plan outlined last year for a careful study of the cause of rots in sweet potatoes, but with the help of Mr. Gillison, the Farm Foreman, we have been able to conduct some experiments in storing potatoes. From results obtained during the past winter it seems that we will be able to keep potatoes either in the house or in banks through the winter with but little loss. A separate article on this phase of the work is appended.

Seed Testing.

Co-operation with the Csmmissioner of Agriculiure, Commerce and the Industries in the enforcement of the seed law was continued until May 15th of this year, when the work was discontinued on account of the withdrawal of the support of the Commissioner. During November and December, 1910, Mr. L. P. Byars, of this office, was appointed special inspector to inspect the cotton fields of a number of prominent seed growers of the State and to take samples of cotton seed diseased with cotton anthracnose. Anthracnose was found in the majority of the samples of seed examined and the report of was made to the Commissioner with the suggestion that he take steps to prevent the sale of diseased seed. A number of samples of field and garden seeds were sent in by various

dealers, and have been tested during the year. No inspectors have been sent out to collect samples on the open market; in fact no official samples have been taken at all since the law went into effect except the few collected by Mr. Byars while he was out last fall. Mr. W. B. Aull, Jr., who was employed to do the analytical work, performed his duties faithfully and well until his position was discontinued by Commissioner Watson on the 15th of May. Since that time Mr. Aull has been transferred to the Station staff and is now rendering very efficient service as laboratory assistant to this Division. It is disappointing to have this work discontinued just at the time we were getting in shape to make some headway with it. It seems to me that this work is sufficiently important to demand some recognition by the Station and by the College. At present it seems that there is no effort being made to enforce this law. Would it not be well for the station to take some steps to insure its enforcement? This, it seems, might be done through some sort of co-operation with the State Department of Agriculture, or if such co-operation could not be secured, the law might be changed so as to give the Station the authority to enforce it.

Cotton and Cow Pea Wilt Work.

This work which is being carried on in co-operation with the Bureau of Plant Industry of the National Department of Agriculture, was begun January 1st, 1911. Since that time we have been making every effort to get the work organized and under way. We were fortunate enough to secure the services of Mr. L. O. Watson for this work and the progress made this year has been largely due to his untiring efforts. We have secured the co-operation of one or more farmers in every County where wilt is causing serious loss, and these men are working with us in an effort to produce high grade seed of the varieties of cotton and cowpeas which are resistant to wilt and root-knot. The best available seed of the Dixie and Dillon varieties of cotton were furnished these co-operative breeders in the spring. These were planted on badly diseased land and the stalks that became diseased during the summer were pulled up and destroyed. During the

latter part of the season Mr. Watson went into the fields of the co-operative breeders and helped each of them to select from 25 to 50 of the best individual stalks for progeny row planting next year. The seed from the best of these stalks to row plantings next year will go to increase plots the following year and from there to the general farm. We plan to keep this breeding work going indefinitely and hope by doing so to keep pure and improve the resistant strains which have been so successfully bred up by the Bureau of Plant Industry. Our co-operative breeders will have between two and three thousand bushels of resistant seed to sell at $1.00 per bushel this winter to other planters who need to plant resistant cotton and cowpeas. These diseases seem to be more wide spread than ever before and a conservative estimate of the loss in this State for this season is about one million dollars. When the plan we have under way is in full force there seems to be no reason why this annual loss might not be prevented.

Through the influence of the Bureau of Plant Industry the hearty co-operation of the Office of Farm Demonstration Work and the Office of Farm Management of the United States Department of Agriculture, have been secured in this work. It is a very important work and I trust will continue to receive the hearty support given it this year.

Co-operative Orchard Work.

During the past spring and winter we have carried on actual spraying operations in 15 orchards in different sections of the State and have visited and given special instructions for spraying in others. The experimental phase of the work has not yielded the results that we had hoped for because of the loss of the fruit this season from cold. In some sections, however, the fruit escaped the cold and has been sprayed throughout the season. Wherever this was the case we have secured some splendid results. We have been able to control both brown rot and scab of peach and plum by spraying with lime sulphur solution, and have controlled bitter rot and scab of apple by spraying with lime sulphur and Bordeaux Mixture.

Mr. Byars, who has assisted with this work, has also done considerable orchard work of a general nature. He has

helped many of the orchardists with their pruning, and has, under the direction of the Entomologist, aided considerably in controlling the insect pests in these orchards. We have every reason to believe that the people with whom we have been co-operating in this work are highly pleased with the results obtained. It is hoped that with more favorable conditions next season a larger number of these experiments can be carried to successful completion. I know of no work which gives such striking results, or which when properly executed will do more good, or bring the people in closer touch with the College.

Respectfully submitted,

H. W. BARRE,
Botanist and Plant Pathologist.

COTTON ANTHRACNOSE.

Report of Progress.

H. W. Barre.

The cotton anthracnose investigation has been continually in progress since the summer of 1908. The report of progress published in the annual report of the Station for 1908–9 gave account of the work up to that time. A summary of last season's work was given in the annual report for 1909-10. It seems that it might be well to report here some phases of the investitigation carried on in 1909-10-11.

During the past two seasons the majority of the time and attention has been devoted to the study of the habits of the fungus under field conditions and to experiments with diseased and disease-free seed.

The Vitality of the Fungus in the Field.

Results obtained during winter and spring of 1909 and reported in the annual report of that year indicated that the spores and filaments of *Glomorella gossypii* would not live

for more than 10 to 11 months in the old diseased bolls in the field. Rotation experiments conducted in 1910-11 bear out conclusions drawn from the studies of 1908-9. The land on which 35 to 40 per cent. of the cotton was destroyed by anthracnose in 1908 was plowed and planted in oats in the fall of that year. Cultures made from the diseased bolls from this field from time to time during the year showed that the fungus had lost its vitality by July 20th, 1909. The following spring, after the oats came off, the land was sown to peas. In the spring of 1910 this land was planted in cotton. For this planting, seed were used which were selected from healthy bolls and stalks from a field where 20 per cent. of the bolls were destroyed by anthracnose. On the 3-acre field where such seed were used no anthracnose at all showed up, either on the seedlings or on the bolls. About one-fourth of an acre in the same field was planted with seed of the same variety and taken from the same plot as the selected seed, but were not selected. Where such seed were used an average of 20 per cent. of the bolls were destroyed by anthracnose. This is further evidence that where clean seed are used a one year's rotation will eliminate the disease.

Buried Bolls.

In order to determine under what conditions the fungus would live longest in the field, a number of badly diseased bolls were collected last November and buried in the soil in the field at various depths ranging from 2 to 8 inches. These bolls were taken up and examined from time to time during the winter. Cultures were made from these at two weeks' intervals beginning with January. After the middle of February it was difficult to get cultures from these buried bolls and after the middle of March we could get none of the spores or filaments to grow. There seemed to be very little difference in the vitality of the fungus at different depths below two inches. This point will be gone into more carefully this winter and spring.

At the same time that these bolls were buried a number of badly diseased stalks were pulled up and carried and piled out at the edge of the field against the fence. Bolls were

taken from these and examined from time to time and cultures were made the same as with those placed in the soil. Up to September 1st the fungus was found to be still alive in these bolls.

The part of the field referred to above where the seed which were not selected were planted, and where the disease developed to the extent that 20 per cent. of the bolls were destroyed, was run over with a stalk chopper early in November and then plowed about 10 inches deep. This turned under practically all the stalks and bolls. This land was then sown to crimson clover. In the spring the clover was turned under and the land was planted again in cotton. This time with the same variety as before but with seed which had been selected from the part of the field where there was no disease. This season there is no anthracnose in this part of the field. This taken together with the culture work on the vitality of the fungus, seems to indicate that we can get rid of the disease without rotation, provided we use seed which are free from the disease and the stalks and bolls are plowed under early in the winter.

Vitality of the Fungus in the Seed.

During the fall and winter of 1909 numerous examinations and cultures were made from seed gathered during the falls of 1907 and 1908. At this time no seed were available which were known to be more than two years old, but from a study of the one and two year old seed it looked as though we might expect the fungus to remain alive in slightly diseased seed as long as the seed remained alive. In April, 1910, we planted in the field seed trom the badly diseased cotton of the 1908 crop. These seed were about 20 months old at the time they were planted. These were planted on land which had not been in cotton for 3 years. On the cotton grown from such seed the disease developed to considerable extent; about 10 per cent. of the bolls being diseased at the end of the season. Adjoining the rows on which these two year old seed were planted were 4 rows of the same variety of cotton planted from seed selected from healthy bolls and stalks in October, 1909. On these no disease at all developed except

at two places where it seems to have spread from diseased stalks on adjoining rows.

During the past spring (1911) we have conducted a number of germination tests of the same sample of seed which came from a badly diseased field in 1908, and in no case has anthracnose developed on the seedlings. Some of these seed were planted in the field again this year on land which had not been in cotton for two years. Several of the seedlings collected from this plot in June were found to be diseased, and later in the season two of the 330 stalks in the plot were found to contain diseased bolls. This would seem to indicate that there is still an occasional seed in this lot in which the fungus is still alive. It will be seen from these results that there was less than one per cent. of the stalks diseased, and less than one per cent of the bolls diseased on this cotton from 1908 seed this season, while on cotton grown from the same seed last year 10 per cent. of the bolls were diseased. Three hundred seed from this lot were germinated in the laborarory in March and April, and the disease did not show up on a single one of these. This is further indication that the seed in this sample which still carry the disease are very rare. We have a quantity of diseased seed of known ages on hand now, and this point will be tested further during the coming season.

The Vitality of the Hyphae and Spores on the Outside of the Seed.

Tests have been made from time to time during the past year with a view of determining the length of the time the spores of the fungus will remain alive on the outside of the seed. Seed which were known to have come from diseased fields have been washed and the washings centrifuged according to method described later in this report, and hanging drop cultures containing the spores made from time to time. The spores have been found to germinate in such cultures nine months after the seed were ginned. We have not been able to get them to germinate after a longer time than this.

Twenty bolls, two to four days old, were inoculated on July 12th, with washings from a sample of diseased seed which were ginned in October of the previous year.

These seeds were washed with a small quantity of sterile distilled water. This water was decanted off and sprayed on to the young bowls with an atomizer. Microscopic examination of the water before the inoculations were made showed about 2,000 anthracnose spores to the drop. Of these 20 bolls two were destroyed at the end seven days, the other 18 matured sufficiently to open, but seven of them were found to contain diseased lint and seed and 16 were diseased on the outside of the boll, two remained free from disease. This would indicate that the fungus had sufficient vitality at this time to cause infection when placed on young bolls in the field.

Assuming that the cotton is ginned about the first of November it seems from these tests that the spores on the outside of the seed remain alive long enough to cause disease on the seedlings when they come up in April or May. This indicates that seed cotton should not be ginned on the same gin immediately following diseased cotton.

Progeny of Seed from Open Bolls Which Contained one or more Diseased Locks

During the past year a careful study has been made of a number of diseased bolls which contained one or more badly diseased or compact locks. These bolls were brought in from the field and careful microscopic examination was made of the boll walls and of the lint and seed in each. Each boll was given a number and careful records were kept of the results of the examinations. The open locks were examined separately and given a different number from the rest of the boll. The "a" numbers refer to the open locks and "d" after the number in the column means that disease was found on the lock. Germination tests were made with a small number of seed from each boll in order to get some idea as to the number of these seed that were diseased. On the 20th of April a number of seed—10 where there were that many available—were placed in test sterile tubes, to which a small amount of absorbent cotton and enough water to cover

the cotton, had been added, and placed for germination. As soon as the seed in each test tube started to germinate it was transferred to the soil in a three inch paper pot in the greenhouse. The seedlings were kept in the pots in the greenhouse for about three weeks and were transfered to the field on May 16th. Each seed and each plant was kept separate from every other from the time the seed were placed in the test tubes for germination, only one seed being placed in each tube and one plant to each pot. The plants were put out in the field in four foot rows and were set four feet apart in the row. This was on land which had not been in cotton for four years.

These plants were kept constantly under observation from the time the seed were placed for germination, and every plant that showed sign of disease was carefully examined. Microscopic examinations were made of all plants that died and of all dead parts of those that lived.

The following table gives the result of this work :

TABLE I.—Results obtained by germinating and planting seed from open and compact locks from diseased bolls.

Cb. No.	From Stalk No.	No. of open locks d—disease	No. of compact locks	Lab. Ger. test.		No. of seed placed in tubes	No. not germinating and diseased	No. transferred to pots	No. that came up	No. that showed disease while in pots	No. that died in greenhouse after coming up	No. transplanted to field	No. that lived after transplanting	Stalk Nos. in field	No. of stalks showing disease on cotyledons and leaves in field	No. stalks showing disease on bolls in field	Average per cent of diseased bolls	No. of locks destroyed
				No. of seed used	No. developing disease													
80	Fert. test plot		2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
80a	"	1		3	3	10P	6	4	2	2	2	0	0	0	0	0	0	
81	"		2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
81a	"	3d		3	3	10P	10	10	0	0	0	0	0	0	0	0	0	
82	"		2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
82a	"	3		3	3	0	0	0	0	0	0	0	0	0	0	0	0	
83	"			0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
83a	"	1d		3	3	0	0	0	0	0	0	0	0	0	0	0	0	
84	"		3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
84a	"	2d		4	4	10P	4	6	6	2	6	0	0	0	0	0	0	
85	"		3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
85a	"	2d		3	3	5	0	5	5	3	2	3	3	1417-19	3	2	5.65	
86	"		3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
86a	"	2d		4	4	5	1	4	2	2	2	0	0	0	0	0	0	
87	"		3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
87a	"	1d		3	3	4	2	2	2	2	0	2	2	1420-21	2	2	11.32	
88	"		1	0	0	5	3	2	2	2	2	0	0	0	0	0	0	

TABLE I.—Continued

Cb. No.	From Stalk No.	No. of open locks d—disease	No. of compact locks	Lab. Ger. test. No. of seed used	Lab. Ger. test. No. developing disease	No. of seed placed in tubes	No. not germinating and diseased	No. transferred to pots	No. that came up	No. that showed disease while in pots	No. that died in greenhouse after coming up	No. transplanted to field	No. that lived after transplanting	Stalk Nos. in field	No. of stalks showing disease on cotyledons and leaves in field	No. stalks showing disease on bolls in field	Average per cent of diseased bolls	No. of locks destroyed
	Fert. test																	
88a	plot	3d		3	3	10P	4	6	6	5	5	1	0	0	0	0	0	
89	"		2	0	0	5	1	4	1	1	1	0	0	0	0	0	0	
89a	"	2d		4	4	10P	6	4	4	3	4	0	0	0	0	0	0	
90	"		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
90a	"	4		3	2	0	0	0	0	0	0	0	0	0	0	0	0	
91	"		4	0	0	5	2	3	2	2	2	0	0	0	0	0	0	
91a	"	1		3	3	5	2	3	3	0	0	3	3	1423-25	1	2	8.54	
92	"		3	0	0	5	5	2	0	0	0	0	0	0	0	0	0	
92a	"	2		4	4	10	8	10	2	2	2	0	0	0	0	0	0	
93	"		4	0	0	5	5	1	0	1	0	0	0	0	0	0	0	
93a	"	1d		2	2	3	1	2	2	1	0	2	2	1426-27	1	2	10.90	
94	736		3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
94a	736	1d		3	3	3	3	3	0	0	0	0	0	0	0	0	0	
95	736		2	0	0	5	3	2	2	2	2	0	0	0	0	0	0	
95a	736	2		4	2	10	1	10	9	4	0	9	8	1428-36	5	8	9.54	
96	736		2	0	0	5	5	0	0	0	0	0	0	0	0	0	0	
96a	736	3		3	2	10	0	10	10	5	3	7	7	2445-51	2	2	2.15	

TABKE I.—Continued

Cb. No.	From Stalk No.	No. of open locks d—disease	No. of compact locks	Lab Ger. test.		No. of seed placed in tubes	No. not germinating and diseased	No. transferred to pots	No. that came up	No. that showed disease while in pots	No. that died in greenhouse after coming up	No. transplanted to field	No. that lived after transplanting	Stalk Nos. in field	No. of stalks showing disease on cotyledons and leaves in field	No. stalks showing disease on bolls in field	Average per cent of diseased bolls	No. of locks destroyed
				No. of seed used	No developing disease													
97	736		4	0	0	5	2	3	0	0	0	0	0	0	0	0	0	
97a	736	1d		3	3	2	0	2	2	2	2	0	0	0	0	0	0	
	F. test																	
98	plots		2	0	0	5	4	1	0	1	0	0	0	0	0	0	0	
98a	"	2d	0	4	4	10	6	10	4	4	4	0	0	0	0	0	0	
99	"		1	0	0	5	2	3	0	3	0	0	0	0	0	0	0	
99a	"	3d		4	4	10P	7	10	3	3	3	0	0	0	0	0	0	
100	"		4	0	0	5	5	3	0	3	0	0	0	0	0	0	0	
100a	"	1d		3	3	3	3	3	0	3	0	0	0	0	0	0	0	
101	"		5	0	0	5	5	1	0	0	0	0	0	0	0	0	0	
102	"		4	0	0	5	3	2	0	1	0	0	0	0	0	0	0	
102a	"	1		3	3	3	1	3	2	2	2	0	0	0	0	0	0	
103	"		2	0	0	5	4	5	1	1	0	1	0	1409	0	0	0	
103a	"	2		0	0	10	5	10	5	0	0	5	5	1437-41	0	5	15.06	
104	"		2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
104a	"	2		4	0	5	0	5	5	0	0	5	4	2440-44	0	3	6.89	
105	"		4	0	0	5	2	5	3	1	1	2	2	1407-08	0	2	11.86	
106a	"	2d		4	4	10P	7	10	3	3	2	1	1	2413	1	1	14.28	
107	"		2	0	0	5	4	5	1	1	1	0	0	0	0	0	0	

TABKE I.—Continued

Cb. No.	From Stalk No.	No. of open locks d—disease	No. of compact locks	Lab. Ger. test. No. of seed used	Lab. Ger. test. No. develoiping disease	No. of seed placed in tubes	No. not germinating and diseased	No. transferred to pots	No. that came up	No. that showed disease while in pots	No. that died in greenhouse after coming up	No. transplanted to field	No. that lived after transplanting	Stalk Nos. in field	No. of stalks showing disease on cotyledons and leaves in field	No. stalks showing disease on bolls in field	Average per cent of diseased bolls	No. of locks destroyed
	F. test																	
107a	plot	2d		3	3	4	1	5	4	4	4	0	0	0	0	0	0	
108	"		2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
108a	"	3		4	0	10	2	10	8	1	0	8	7	2452-59	2	7	11.02	
109	"		3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
109a	"	2d		0	0	5	3	5	2	2	0	2	1	1442-43	1	1	13.33	
110	737		2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
110a	"	2d		3	0	10P	4	10	6	3	0	6	3	2419-24	2	2	11.30	
111	3633		3	0	0	5	3	2	0	0	0	0	0	0	0	0	0	
111a	3633	1d		0	0	5	4	5	1	1	0	1	1	1444	1	1	4.16	
112	737		3	0	0	5	4	5	1	1	1	0	0	0	0	0	0	
112a	737	1d		3	3	4	2	4	2	1	0	2	2	2482-83	1	2	4.30	
113	738		3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
113a	738	1d		0	0	5	4	5	1	1	1	0	0	0	0	0	0	
114a**	3637	4		6	0	10	1	10	9	1	1	8	6	3402-09	3	4	12.62	
115	738		1	0	0	5	1	5	4	4	0	4	2	1410-13	0	2	3.36	
115a	738	3d		0	0	10	0	10	10	3	0	10	6	1445-54	2	6	10.07	
116	739		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

C. B. Nos. marked thus ** came from next to diseased bolls.

TABLE I.—Continued

Cb. No.	From Stalk No.	No. of open locks d—disease	No. of compact locks	Lab. Ger. test.		No. of seed placed in tubes	No. not germinating and diseased	No. transferred to pots	No. that came up	No. that showed disease while in pots	No. that died in greenhouse after coming up	No. transplanted to field	No. that lived after transplanting	Stalk Nos. in field	No. of stalks showing disease on cotyledons and leaves in field	No. stalks showing disease on bolls in field	Average per cent of diseased bolls	No. of locks destroyed
				No. of seed used	No. developing disease													
116a	739	3d		3	0	10	1	10	9	2	0	9	8	2427-35	2	3	4.30	
117	741		2	0	0	5	4	5	1	1	1	0	0	0	0	0	0	
117a	741	2d		0	0	10	4	10	6	3	0	6	3	1455-60	2	3	19.83	
118	741		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
118a	741	3d		2	0	10P	6	10	4	4	2	2	2	2425-26	2	2	40.62	
119	741		2	0	0	5	3	5	2	2	2	0	0	0	0	0	0	
119a	741	2d		0	0	10	8	10	2	2	1	1	0	1461	0	0	0	
120a	741	5d		4	2	10	1	10	9	6	1	8	3	2474-81	2	3	18.65	
121	741		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
121a	741	3d		0	0	10	2	10	8	4	2	6	3	2468-73	1	3	14.87	
122	742		1	0	0	5	2	5	3	2	0	3	2	1401-03	2	2	21.47	
122a	742	4d		0	0	10	2	10	8	5	1	7	2	1462-67 & 1473	2	2	20.99	
123	742		4	0	0	5	3	5	2	2	2	0	0	0	0	0		
123a	742	1d		0	0	3	1	3	2	2	2	0	0	0	0	0	0	
124	742		3	0	0	5	1	5	4	4	4	0	0	0	0	0	0	
124a	742	1d		3	3	3	2	3	1	1	0	1	0	1468	0	0	0	
126	742		2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
126a	742	2d		0	0	10	6	10	4	4	2	2	2	1469-70	2	2	17.54	

TABLE I.—Continued

Cb. No.	From Stalk No.	No. of open locks d—disease	No. of compact locks	Lab. Ger. test.		No. of seed placed in tubes	No. not germinating and diseased	No. transferred to pots	No. that came up	No. that showed disease while in pots	No. that died in greenhouse after coming up	No. transplanted to field	No. that lived after transplanting	Stalk Nos. in field	No. of stalks showing disease on cotyledons and leaves in field	No. stalks showing disease on bolls in field	Average per cent of diseased bolls	No. of locks destroyed
				No. of seed used	No. developing disease													
127a	742	4d		0	0	10	3	10	7	2	0	7	2	1471-78	0	2	10.38	
128	742		*3	0	0	5	0	5	5	5	2	3	1	1404-06	1	1	4.28	
129	3637		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
129a	3637	3d		0	0	10	7	10	3	3	3	0	0	0	0	0	0	
130	743		3	0	0	5	5	4	0	0	0	0	0	0	0	0	0	
130a	743	1d		3	1	1	0	1	1	0	0	1	0	1479	0	0	0	
131	x8		2	0	0	5	4	5	1	1	1	0	0	0	0	0	0	
131a	x8	2d		0	0	10	4	10	6	5	2	4	3	2460-63	3	3	8.93	
132	x7		2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
132a	x7	2d		0	0	10	4	10	6	4	2	4	2	2464-67	0	2	2.80	
134	x7		2	0	0	5P	5	2	0	0	0	0	0	0	0	0	0	
134a	x7	2d		0	0	10	7	10	3	3	3	0	0	0	0	0	0	
135**	x7& x8	?	?	0	0	4	2	4	2	1	0	2	1	3449	0	1	20.00	
136	736		3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
136a	736	2		0	0	10	3	10	7	3	0	7	5	1481-86	1	4	28.68	
137	3716		5	0	0	5	5	5	0	0	0	0	0	0	0	0	0	
137a*	137*	5d		0	0	10	1	10	9	3	0	9	7	3410-18	2	7	14.23	
138	3717		3	0	0	5	5	3	0	0	0	0	0	0	0	0	0	

C. B. Nos. marked thus ** came from next to diseased bolls. *Next to Cd. 137.

TABLE I.—Continued

Cb. No.	From Stalk No.	No. of open locks d—disease	No. of compact locks	Lab. Ger. test.		No. of seed placed in tubes	No. not germinating and diseased	No. transferred to pots	No. that came up	No. that showed disease while in pots	No. that died in greenhouse after coming up	No. transplanted to field	No. that lived after transplanting	Stalk Nos. in field	No. of stalks showing disease on cotyledons and leaves in field	No. stalks showing disease on bolls in field	Average per cent of diseased bolls	No. of locks destroyed
				No. of seed used	No. developing disease													
138a	3717	1d		0	0	5	5	5	0	0	0	0	0	0	0	0	0	
139	3717		5	0	0	5	5	0	0	0	0	0	0	0	0	0	0	
140**	3716	4d		6	0	10P	1	10	9	0	0	9	8	3478-86	0	7	11.73	
141a	3718	5d		6	0	10P	0	10	10	2	0	10	8	3419-28	2	7	7.80	
142a	3637		4	0	0	5	5	5	0	0	0	0	0	0	0	0	0	
142b**	3637	4		6	0	10	2	10	8	0	0	8	7	3460-67	0	5	7.14	
143a	3637	4		0	0	10	10	10	0	0	0	0	0	0	0	0	0	
144	3713		4	0	0	5	5	3	0	0	0	0	0	0	0	0	0	
144a	3713	1d		0	0	5	3	5	2	2	2	0	0	0	0	0	0	
145	3713		4	0	0	5	3	5	2	2	2	0	0	0	0	0	0	
146	3815		5	0	0	5	2	5	2	2	0	2	1	1415-16	0	1	5.76	
147a	3815	5d		0	0	10P	1	10	9	4	1	8	6	2484-92	2	3	2.10	
148a	x6	4		0	0	10	1	10	9	1	1	8	8	3429-36	0	7	9.95	
149	x6		5	0	0	10	9	10	1	0	0	1	1	3437	0	1	8.33	
150	731		2	0	0	3	3	0	0	0	0	0	0	0	0	0	0	
150a	731	2d		0	0	10	6	10	4	4	4	0	0	0	0	0	0	
151	726		4	0	0	5P	5	5	0	0	0	0	0	0	0	0	0	
151a	726	1d		0	0	2	0	2	1	0	0	1	1	1487	0	0	0	
152a	3813	4		0	0	10	1	10	9	1	0	9	8	1488-96	0	7	10.00	

C. B. Nos. marked thus ** came from next to diseased bolls.

TABLE I.—Continued

Cb. No.	From Stalk No.	No. of open locks d—disease	No. of compact locks	Lab. Ger. test. No. of seed used	Lab. Ger. test. No. developing disease	No. of seed placed in tubes	No. not germinating and diseased	No. transferred to pots	No. that came up	No. that showed disease while in pots	No. that died in greenhouse after coming up	No. transplanted to field	No. that lived after transplanting	Stalk Nos. in field	No. of stalks showing disease on cotyledons and leaves in field	No. stalks showing disease on bolls in field	Average per cent of diseased bolls	No. of locks destroyed
153a**	736	4		0	0	10	0	10	10	1	0	10	9	1438-47	0	8	4.95	
154a**	743	4		0	0	10	0	10	10	1	0	10	10	3468-77	0	9	5.96	
155	3901		2	0	0	4	4	4	0	0	0	0	0	0	0	0	0	
155a	3901	2d		0	0	10	2	10	8	5	0	8	7	2493-100	1	3	6.89	
156a	3901	4d		0	0	10	0	10	10	1	0	10	9	2401-06 &1497-100	1	8	10.21	
160	3821		3	0	0	4P	2	4	2	2	2	0	0	0	0	0	0	
160a	3821	1		0	0	5	1	5	4	0	0	4	4	2336-39	1	1	4.30	
161	3821		2	0	0	5P	5	5	0	0	0	0	0	0	0	0	0	
162	3821		5	0	0	5P	5	0	0	0	0	0	0	0	0	0	0	
163a	3821	2d		0	0	10P	4	10	6	4	1	5	4	2414-17	2	3	9.80	
164	3908		1	0	0	5P	3	2	1	1	0	1	0	0	0	0	0	
164a	3908	3		0	0	10	9	9	1	1	1	0	0	0	0	0	0	
165	730		2	0	0	5P	5	2	0	0	0	0	0	0	0	0	0	
165a	730	2d		0	0	10	3	10	7	4	1	6	6	2407-12	0	5	7.20	
166	x4		2	0	0	5	5	4	0	0	0	0	0	0	0	0	0	
166a	x4	3		0	0	10	10	9	0	0	0	0	0	0	0	0	0	
1908				0	0	10	0	10	10	0	0	10	7	3450-59	0	7	5.90	

C. B. Nos. marked thus ** came from next to diseased bolls.

It will be seen from the above table that the majority of the seed from the compact badly diseased locks either failed to germinate or died before they were transplanted to the field. A large majority of seedlings which grew from such seed showed signs of the disease on their stems ond cotyledons, and disease bolls developed on every stalk which grew to maturity from such seed.

It will also be seen from the table that the large majority of the stalks from seed from the open loeks produced bolls which were diseased. There does not seem to be a great difference in the amount of disease on the progeny of the open locks on which no disease was found, and those upon which disease was found upon microscopic examination. All open locks from diseased bolls seemed to contain diseased seed. The highest per cent of disease was found on the stalks grown from the seed from the open locks which were so badly diseased that spores and hyphae of the fungus were readily found upon microscopic examination. The table shows that bolls which showed no sign at all of disease but which grew by the side of diseased bolls on the same branch may carry diseased seed. Fewer of the seedlings from seed from such bolls were diseased but the per cent of disease was almost as high as on the progeny of the open locks from definitely diseased bolls.

Getting Rid of the Disease by Seed Selection.

During the fall of 1909 we went into the field where anthracnose had destroyed about 20% of the bolls and selected cotton seed from the healthy bolls and stalks from three varieties of cotton (Cook, Columbia and Blue-Ribbon). These seed were planted in the spring of 1910 on land which cotton had been left off of for one year. In every case where such seed were planted only an occasional diseased boll developed. There was less than 1-10 of 1% of the bolls diseased in the 4 acres planted in these seed.

Seed of the same varieties and from the same field which were not selected but were taken from diseased

stalks and bolls, as well as from healthy ones, were planted in the same field adjoining the portion planted with healthy seed. On the area planted with such seed 20% of the bolls were destroyed by anthracnose. During fall of 1910 cotton for seed for this season (1911) was picked from parts of the field where there was no disease. These seed were planted back on the same land this season and no disease developed.

This method of eradicating the disease has been recommended to farmers throughout the State who have suffered loss from enthracnose, and a number of letters have been received from farmers in different sections of the State stating that they have entirely eliminated the disease from their places by this method.

Inoculations.

During July and August of the past season a number of inoculations were made on bolls of various ages in the field with a view of securing additional data relative to the method and time of infection of the bolls. These bolls were tagged on the day that the flowers opened and the age of the boll dates from that time.

The following table gives the results obtained from these inoculations.

TABLE II.

Date of inoculation.	No. bolls inoculated.	Age of bolls—days.	Culture used.	Method of inoculation used.	No. bolls destroyed.	No. bolls diseased on outside.	No. bolls diseased on inside.	No. bolls free from disease.	Total No. diseased bolls.
7-12-11	22	1 to 4	Washings from sample No. 10	Atomizer	2	16	7	2	18
7-17-11	30	Various	Pure culture	Pipette	3	27	17	0	30
7-25-11	20	5	"	Atomizer	2	16	9	2	18
7-28-11	20	10	"	"	1	18	6	1	19
7-29-11	20	3	"	"	1	16	4	3	19
8- 2-11	20	15	"	"	0	19	8	1	19
8- 2-11	10	6	"	"	1	15	2	3	16
8- 7-11	20	10	"	"	2	17	2	1	19
8- 9-11	20	20	"	"	0	17	2	3	17
8-12-11	20	20	"	"	0	17	1	3	17

TABLE II.—Continued.

Date of inoculation.	No. bolls inoculated.	Age of bolls—days.	Culture used.	Method of inoculation used.	No. bolls destroyed.	No. bolls diseased on outside.	No. bolls diseased on inside.	No. bolls free from disease.	Total No. diseased bolls.
8-16-11	5	20	"	Sterile platinum needle	0	5	5	0	5
8-21-11	5	25	"	"	0	4	4	1	4
8-25-11	20	–	"	Atomizer	3	13	5	4	16
8-30-11	17	5	"	"	6	4	4	7	10
9- 6-11	24	4	"	"	1	19	15	4	20
9- 6-11	6	6	"	"	1	5	5	0	6
	286	–	–	–	23	228	96	35	251
		%					41.6		87.7

These inoculations, with the exception of 20 bolls inoculated on the 12th day of July, were made from pure cultures of the fungus and special precautions were taken to see that no bacteria were present. A number of the bolls on which the disease developed were brought in to the laboratory and examined. No organism other than *Glomorella gossypii* was found in the newly infected areas or in the advancing diseased areas, and this fungus was readily isolated from such areas in pure culture. In order to further ascertain whether there might be other organisms associated with *Glomorella gossypii* in the cause of this disease, a number of isolations were made from the early stage of the disease on bolls which were infected by natural means. We found that where the proper precautions were taken no other fungi or bacteria developed in the cultures made from such areas.

It will be seen from the above table that a relatively small number of the inoculated bolls were destroyed by the disease. The weather conditions at the time of the inoculations probably had something to do with this. That the fungus remained alive, however, and caused disease on the hull of the boll in the majority of the cases is shown by the fact that 87.7% of the inoculated bolls were diseased on the outside.

It will also be seen from the table that the fungus gained entrance in to 41.6% of the bolls and caused disease on the seed and lint. Many of these bolls matured and opened, showing little sign of the disease, except for an occasional diseased spot on the hull. In the majority of cases where the seed and lint were found diseased, however, the bolls were not opened out wide and the lint was compact and slightly discolored. Seed from a number of these bolls which matured in this manner will be planted next season with a view of determining the amount of disease that will appear on the plants which develop from them.

Prevalence of the Disease in the State.

Anthracnose seems to have been wide spread again this season and has caused extensive losses in every sec-

tion of the State. It was especially destructive in the North Eastern section of the State. One farm visited near Chester showed a loss of from 20 to 30% on 25 acres. Two different farms in the vacinity of Chesterfield showed an average of 40 to 50% loss in 60 and 70 acre fields. Near Cheraw one farm of over 800 acres showed an average of about 10% of the bolls diseased on the entire farm. In the vicinity of Florence a number of farms were badly diseased. At several places between Timmonsville and Lamar the disease was especially bad. On one farm in this vucinity 6 acres of Triumph cotton was so badly diseased that 60% of the bolls failed to open. On the 20 farms visited this season careful estimates were made of the loss caused by the disease. On these 20 farms, including about 1800 acres in cotton careful estimate shows that anthracnose caused more than $10,000 loss. We have no way of getting accurate data as to the total loss in the State this season, but from the number and the severety of the cases which have come to our attention it seems that a conservative estimate of the loss this season would be at least one million dollars.

A study of the history of the disease on the farms visited this season indicates that it was brought on practically every one of these farms through seed. In many cases the variety which had brought the disease on to the farm had been continued for several years witout any effort having been made to get rid of the disease. In such cases the disease has become more severe from year to year and has each year spread on to sections of the farms which were previously free from it.

The disease has been observed this season on several varieties which had been previously considered exceptionally free from it. On one farm near Cheraw, a field of Cleveland Big Boll was found to be badly diseased. This was the first time a bad case of anthracnose had been observed on this variety. One case is reported from near Sumter where 10% of the crop of Tool was destroyed. At Chester, Hope's Mexican Big Boll was found very badly diseased. The worst diseased fields visited this

season were those planted in Brown's No. 1. This variety was badly diseased wherever planted. Blue Ribbon, Triumph, and practically all of the upland long staple varieties continue to suffer from attacks of the disease. From observations made thus far it seems that all varieties of cotton are subject to anthracnose. It would be well for every planter to keep this in mind and to take precautions to keep the disease out of his cotton.

THE DETECTION OF ANTHRACNOSE IN COTTON SEED.

H. W. Barre and W. B. Aull, Jr.

From the work done at the South Carolina Experiment Station during past three years it has been found that anthracnose lives through the winter in the seed, and that this disease is thus being spread by the planting of diseased seed. Microscopic examination of diseased locks of cotton shows not only the filiaments of anthracnose in the seed but also the filiaments of anthracnose in the filiaments and spores in the lint and on the fuzz that remains on the seed after the cotton is ginned.

In the seed law of South Carolina there is a clause prohibiting the sale of any seed which carry communicable diseases. It is reported that the loss due to anthracnose alone in this State last year was four million dollars. When we consider what this loss means to the farmer the value of an accurate method for the detection of anthracnose in the seed becomes evident. This work was undertaken with the view of determining some method which would be rapid as well as accurate. The results of the investigation are given below.

The Centrifuge Method.

Having found the anthracnose spores on the fuzz of the seed, the problem resolved itself into the collecting of

those spores and counting them. To do this we resorted to the Centrifuge Method used by Prof. Bolley and others. The following method was devised: 300 seed were placed in a sterile glass flask with 100 c. c. of sterile distilled water. The flask was shaken thoroughly for ten minutes, thus washing the spores off of the seed. Ten c. c. of the washings were placed in each of the two sterilized centrifuge tubes and the centrifuge was run for ten minutes at 1000 revolutions per minute. The spores, with other suspended matter were thrown down to the bottom of the tubes. With the aid of a sterilized pipette, some of the sediment in the bottom of the tube was obtained. Two drops of this sediment were mounted on a glass slide, using a 7-8 inch square cover glass and microscopic examination was made. Knowing the area of the cover glass, and also that of the field of the 1-6 inch objective, it was an easy matter to calculate the number of spores in two drops of the sediment. Three or four determinations were made and the average was taken. When from three to four determinatious on one sample were made, the time required varied from forty-five minutes to one hour, depending on the amount of anthracnose present. This method of course did not give the total number of anthracnose spores present in the sample because only the number in two drops of the sediment was counted. To get the total number the following change was made in the method: After centrifuging 10 c. c of the washings, the top 6 c. c were pipetted off. The other 4 c. c were shaken up well and two drops mounted and the spores counted as before. The number in the 4 c. c. was calculated, which corresponded to 10 c. c. of the washings. The total number of spores on the 300 seed was obtained by multiplying this result by 10 and the number per seed by dividing this last result by 300. The pipetting off of the top 6 c. c. after the washings had been centrifuged did not alter the result because all of the spores had been thrown down to the bottom. Actual miscropic examination of the top 6 c. c. of the centrifuged washings did not show the presence of any spores.

Spores of a number of other fungi such as Fusarium,

Aspergillus, Cladosporium and others were found in practically all of the samples examined. The spores of these and of others which were found from time to time differed in size and shape from anthracnose spores so that there was little trouble in distinguishing between them. Cultures made from the washings from time to time enabled us to keep a line on the fungi to which certain kinds of spores belonged.

This proved to be a very accurate method for determining the amount of anthracnose on the outside of the seed, but of course gave no index as to the amount of disease which would develop when such seed were germinated. It has been found in the work here that where the disease is in the seed it always shows up on the seedlings when these seed are germinated. In order then to check up the centrifuge results we resorted to the germination of the seed and a study of the resulting seedlings.

Germination Methods

The first method tried was the ordinary one using blotters and cloths. The seed were placed between the folds and kept moist but not wet. The temperature was controlled by a thermo-regulator on the germinator. Although good germinations were obtained by the method, the chance of diseased seedlings contaminating those not diseased was too great and this method was discarded.

In order to eliminate the possibility of contamination Petri dishes were tried. A piece of blotter the size of the dish was placed in each and the dishes were sterilized in the hot air sterilizer at 150 degrees C. After cooling, one seed was placed in each dish, the blotter was moistened with distilled sterile water and the dishes stacked in the germinator. The per cent germination by this method was not very high due probably to the lack of uniformity of moisture around the seed. A change was made in the method by using two pieces of blotter in each dish, one below the seed and one above. Fairly good germinations were obtained by this method, but it

was found that the seed in germinating often pushed the cover off the dishes. In such case the chance for contamination was not as great as when blotters and cloths were used, still the seedlings were exposed to the atmosphere of the germinator and were liable to become contaminated by spores which might be present in the germinator from previous germinations. Hence this method was discarded.

Test tubes were next tried. Water was placed in the bottom, then a cotton plug was pushed in until the water just covered it and the tube was plugged with cotton at the top. These tubes were then sterilized in the auto-clave under 20 pounds pressure. After cooling, one seed was placed in each tube, the tubes were placed in a wire basket and set in the germinator. The disease, when present, began to show up in from 4 to 6 days on the stems and cotyledons of the seedlings. Each seedling was examined microscopically. This method avoided the chance of contamination, but the per cent of germination was not so high as in the former method.

A number of methods were tried with view of getting a high per cent germination under sterile conditions. The following method, which proved very successful in every way, was finally adopted:—blotting paper was cut up into pieces about one centimeter square, and enough of these pieces were placed in the bottom of a test tube to form a layer about 1-2 inch deep. The pieces of blotter were wet with distilled water and pressed down gently with a stirring rod. The tubes were plugged with absorbent cotton and sterilized in the autoclave for twenty minutes under 20 pounds pressure. More pieces of blotter were cut, placed in crystallization dish, and sterilized in the hot air sterilizer for twenty minutes at 150 degrees C. Atfer the tubes had been sterilized and had cooled, one seed was placed in each tube with a pair of sterilized forceps. From 8 to 10 pieces of the sterilized blotter were dropped on top of each seed before the tube was plugged. The tubes were then placed in a basket and set in the germinator. Fifty seed were used for each test. In from 4 to 6 days, the anthracnose showed up well on the diseased seedlings. Each seedling was examined under the miscroscope, precaution being taken to use only sterile needles, slides, cover glasses and

sterile distilled water. With this method a higher per cent germination was obtained than with any other. As the seed were germinated under absolutely sterile conditions any disease showing up must of course have come from diseased seed.

The following table shows the differences in germination and the differences in the amount of disease of these samples when germinated by the foregoing methods:

Sample No.	No. of tests.	Seed Bed	No. seed used in each test	Temperature C.	Average per cent germination	Average per cent disease	Duration of test days
10	4	Blotters.	50	20-30	65.25	64.98	12
10	1	Cloths.	50	20-25	72.00	58.33	12
10	4	Cotton Plug-Test Tubes.	50	25-30	57.00	70.50	11
10	9	Pieces of blotter above and below seed in Test Tubes.	50	27-35	76.22	62.71	9
10	1	Pieces of blotter below seed in Test Tubes.	50	27-35	44.00	No. Exam. made	30
35	3	Blotters.	50	30-33	66.66	51.33	8
35	1	Cloths.	50	30	67.00	54.00	9
35	2	Blotters below seed in Petri Dishes.	50	30	60.00	14.00	10
35	2	Cotton Plug-Test Tubes.	50	30	51.00	9.00	7
35	2	Pieces of blotter below and above seed in Test Tubes.	50	26-33	78.00	9.00	9
45	3	Blotters.	50	30-35	92.66	56.00	7
45	1	One blotter below and one above seed in Petri Dishes.	50	30-33	88.00	54.00	6
45	4	Cotton Plug-Test Tubes.	50	30	13.50	48.00	10
45	11	Pieces of blotter below and above seed in Test Tubes.	50	28-36	87.27	46.54	10

An examination of the above table shows that sample Number 10 when germinated in test tubes using piece of blotter above and below theseedgaveanaverage vbg cf srd vbg vbgkk above and below the seed gave an average germination of 76.22 per cent which is 4.22 per cent higher than where cloth was used, 10.97 per cent higher than where blotters were used, and 19.22 per cent than where test tubes with cotton plugs were used. The per cent disease is also 2.27 per cent lower than where blotters were used, and 7.79 per cent lower than where tubes with cotton plugs were used, but 4.38 per cent higher than where cloths were used.

In sample 35 the test tubes using blotters also gave the highest per cent germination and the lowest per cent disease. The use of blotters and cloths for germination in this sample show very forcibly the possibility of contamination among the seedlings.

In sample 45 the blotters gave the highest per cent germination and also showed the highest per cent disease, while the test tubes using blotters gave the lowest per cent disease as in sample 35, although in this sample the difference is not so great.

It is quite an interesting fact that sample 10 germinated an average of 76.22 when pieces of blotter werd used in the bottom and a few pieces were placed on top of each seed, yet when the pieces of blotter were left off of the top of the seed, this same sample under the same conditions, showed a germination of only 44 per cent.

As the test tube method using pieces of blotters above and below the seed gave as high per cent germination as the other methods and at the same time eliminated all chance of contamination we have decided to use it exclusively in all disease seed work.

There is still one big factor to be considered. The question arises, will the field conditions bear out the laboratory tests? Twenty samples of the same seed worked on in the laboratory were planted in the field last spring on land that had not been in cotton for three years. These tests are not

yet complete. The total number of bolls and the number diseased on each stalk will be counted. From these data the per cent disease will be calculated.

SWEET POTATO ROTS.

Methods of Preventing.

H. W. Barre.

This work with sweet potatoes has been continued this season along somewhat the same lines as heretofore. Having found that blackrot and stem-rot were both causing serious trouble in potatoes in storage, measures were taken last season to secure potatoes for storage which were free from disease. The potatoes which were bedded were affected with black-rot —slips were planted from these early in the season. As soon as the vines on these plants were long enough these were used to make cuttings for planting the balance of the field. When the potatoes were harvested on November 7th, those grown from the slips were found to be badly affected with black rot while the ones grown from vines were free from disease. One bin in the potato house was filled with diseased potatoes and two bins were filled with potatoes grown from vines and were free from the disease. These bins hold about 25 bushels. An oil stove was kept burning in the house all the time during the first two weeks and both of the windows left open all of the time except when the nights were cold. This kept the temperature between 65 and 80 degrees, and allowed plenty of ventilation. By this means the excessive moisture was driven out of the potatoes. The end of the two weeks the house was closed up and the temperature allowed to go down to between 50 and 60 degrees and we tried to keep it at this during the winter. Several times during January, however, the temperature went down to 45 degrees.

There was a freeze on the 30th of October, while these potatoes were still in the field and when they were dug a week

later it was found that a great many of the potatoes that were near the surface of the soil had been frozen. We tried to discard all that had been injured by the freeze but it was impossible to detect those that had been slightly frozen. About a month after the potatoes were stored an occasional one was found affected with the soft rot. Rhizopus was easily isolated from these. In practically every case of this rot, however, the trouble started on the large end of the potatoe —the end nearest the surface during the freeze before they were gathered. The rot did not seem to make much headway, however, and it looked as though it was unable to attack the potatoes which had not been injured by the freeze. During January and February the black rot and the nectria rot were found to be making considerable headway on the bin bushels that were rotten. Bin Number 2, which had been fill-filled with the diseased potatoes. Little of this was found in the bin filled with healthy potatoes.

On March 14th, the potatoes in those bins were sorted out and measured. Bin Number 1, which contained the diseased potatoes, measured out 12 bushels of sound potatoes and 8 ed with the potatoes grown from vines and were free from disease were sorted and measured at the same time. Bin Number 2 contained 18 bushels of sound and two bushels of rotten potatoes, and Bin Number 3 contained 20 bushels sound, and 2 1-2 bushels rotten. The majority of those that rotted in Bin Numbers 2 and 3 were completely destroyed and gave evidence of having rotted from soft rot. The majority of those that rotted in Bin Number 1 were found to be affected with nectria rot and with black rot. Some of these were found affected also with Rhizopus and Penicillium. From these results it seems that had it not been for the freeze in October which caught the potatoes in the field we would have had no trouble in keeping them. In spite of this we lost only 10 per cent of those that were free from disease when they were put in storage, while 40 per cent of those which were diseased when stored were destroyed. The fact that the soft rot did not seem to be able to make any headway except on the injured potatoes even where those that were destroyed by

the rot were surrounded by healthy ones is very much to the credit of this method of storing.

At the time the potatoes were harvested about 45 bushels were stored in three banks. Banks Numbers 1 and 2 were filled with potatoes grown from vines and which were apparently free from disease while bank Number 3 was filled with those grown from slips and were badly affected with black rot. The banks were made in the usual way. The surface of the ground was leveled off and covered with about 6 inches of pine straw, a box made out of 6 inch boards and with numerous two inch holes bored in it was placed on end in the center of the bank and the potatoes were piled up around the box. Corn stalks were placed next to the potatoes, these were covered with straw, and then the dirt was put on. At the time the banks were made only a small quantity of soil, a layer about 2 inches thick, was placed over the straw. Sixteen days later on the approach of colder weather the banks were covered with about 5 inches of soil. The boxes in the middle of the banks were kept open during warm days but were closed at night and during the cold days. Thermometers were kept in these banks and were read three times daily, at 7 o'clock in the morning, at noon, and at 7 o'clock in the evening. The temperature varied in these banks from 48 to 66 degrees F during the winter but never varied more than 5 degrees in one day.

These banks were opened on the 26th, of March, and the potatoes sorted and measured. Bank Number 1 contained 12 bushels of sound and 1 1-4 bushels of rotten potatoes, while in bank Number 2 there were 10 bushels sound and one rotten, and in bank Number 3, 9 bushels were sound and 6 rotten—all potatoes that showed any rot at all were classed as rotten.

It will be seen that the proportion of rotten to sound potatoes here is about the same as in the house. From these results it seems that it is safe to store potatoes in banks in this climate provided they are free from disease when put up and the banks are properly made.

REPORT OF ENTOMOLOGIST.

Clemson College, S. C., Nov. 29th, 1911.

Mr. J. N. Harper, Director, Clemson College, S. C.

Dear Sir: I herewith submit the report of the Division of Entomology of the South Carolina Experiment Station, for the fiscal year ending June 30th, 1911.

For convenience the work is reported under the following sections:

Organization.
Correspondence.
Work under the Hatch Fund.
Work under the Adams Fund.
Cooperative Experimental Field Work.
Miscellaneous Investigations.

Organization.

By action of the Board of Trustees on March 12th, 1911, the Entomologist was placed in charge of all the Entomological work of the College and Station, including the work of the State Entomologist. This combination makes every member of the staff available for experimental and research work aside from the regular College and Entomological duties. Mr. W. A. Thomas, formerly in charge of the Entomological Inspection work, preferred to take charge of a research problem in the Station and accepted the newly created position of Assistant Entomologist. Mr. Thomas is in charge of the insect field laboratory at Marion, which was established for the purpose of investigating the Entomology of the Eastern portion of the State. Mr. J. A. Dew, who served this Division as Student Assistant during the year, was elected assistant Entomologist at the July meeting of the Board, and is now in charge of the insect field laboratory at Sniders, which was established for the purpose of investigating the Entomology of the Southern portion of the State. The object and work of the field laboratories is explained in another part of this report.

Prof. W. P. Gee was called from the University of Wiscon-

sin to the position of Assistant Professor of Entomology and Assistant State Entomologist. Prof. Gee is a graduate of this College, in the class of 1908, and since graduation has pursued very aggressively and very creditably fellowship work in the Universities of South Carolina and Wisconsin. Mr. Gee comes to us not only eminently prepared for teaching and State entomological work, but fresh from the modern laboratories he is a most valuable member of our research work. He has taken charge of one of the Station projects.

The gentlemen on the Entomologist's staff, since their appointment, have served with signal ability and fidelity; they love their work and the outlook of the Division has never before been so encouraging.

Correspondence...

The correspondence has greatly increased over previous years, and this phase of the work receives most careful attention; every letter receives personal consideration and thought. Many of the inquiries coming to our attention are of such a nature that no immediate relief can be given and the remedy must wait until the proper time has arrived. In order to enable the Division to render the best possible service a reminder system is operated by means of which the troubles can be followed up and advice sent to the various correspondents periodically when the proper time for action arrives.

Miscellaneous troubles that cannot be handled under work already organized are recorded by the Stenographer in a reminder file maintained for that purpose. When, however, the trouble can be classified under work already in progress, the case is filed in the Entomologist's office and handled when the field work is carried to the section of the State from which the case was reported. An example of the first is the boll worm. This may be reported in June when nothing can be done, but the case is filed and information sent in September when the time for action is approaching. An example of the latter is the San Jose scale; owing to the extensive cooperative experimental work such inquiries are classified with the schedules in the office and direct assistance is given when the winter work is carried to that section of the State.

Work Under Hatch Act.

The limited appropriations from the Hatch fund were utilized for purchasing and equipping spray pumps to be used in cooperative experimental orchard work which is carried on by funds appropriated from another source. This Division, has, at present, 14 fully equipped barrel pumps representing the best type manufactured and which are used in this work. The object and methods of the work is explained under —"Cooperative Experimental Field Work," in another part of this report.

Work Under the Adams Act.

There were two projects pursued under the Adams fund during the past year:

1. The investigation of Strongyloid parasites in the digestive tract of ruminants.
2. The relation of temperature and moisture to insect activity.

A third project recently approved is at present being organized at the insect field laboratory at Sniders in Colleton County. It is project Number 16, "A study of the cotton and corn Wire Worm, *Horistonotus curiatus, Say.*"

Project 1.:

The investigation of Strongyloid parasites in the digestive tract of ruminants, has been continued mainly in the form of pasture observations and the conclusions coincide with those reported in Bulletin Number 137 and in the 22nd, annual report of the Experiment Station. The control methods recommended are entirely practical for the Piedmont sections, but a further study of the pasture rotation methods applicable to the low-lands of the State will be made. The specifice cause of the disease has not been determined, and this phase of the problem is requiring our attention at the present time, and requires a careful anatomical study of the parasites as well as a careful study of the blood contents of the host. The laboratory has been equipped for the purpose of pursuing this phase of the investigation.

Project 2:

The relation of temperature and moisture to insect activity,

has been continued throughout the year. A large amount of data has been accumulated, the work having been begun with species that could be easily observed in all stages of development; the American tent caterpillar, *Malacasoma Americana,* and the Squash bugs, *Anasa tristis,* and *Anasa armiger,* and the Harlequin cabbage bug, *Murgantia histrionica,* furnish abundant material in this locality. A preliminary report of the American tent caterpillar was published in bulletin Number 158 of this Station, and a current report of the work on the squash bug is now in preparation and will be published as a Station bulletin by Mr. J. A. Dew, of this Division. The details of the tent caterpillar work during the last season were in charge of Mr. C. B. Faris, a Senior student of this Division. Prof. Gee and C. B. Faris conducted investigations on the Harlequin bug, an incidentally on the potato beetle. Under this same project Prof. W. P. Gee has undertaken a detailed investigation of the corn weevil, *Calandra oryzae,* which is so destructive to stored corn and other stored grain in our Southern agriculture. This investigation has already been planned and is now in progress.

When interpreting the records of the work so far carried out, it was impossible to account for the variations in phenomena in the same and among the different species studied. It would appear superficial to conclude that every species is governed by its own distinct laws. The variations could not be successfully attributed to hereditary tendencies, and the records so far would indicate that the moisture factor so little understood caused the bias. Preparations were begun for determining the value of both moisture and temperature factors. While it is a comparatively easy matter to control temperature with first-class thermostats and electrical heating attachments, the problem of moisture control is more complicated. While we have standardized apparatus with which accurate reading of moisture is possible yet the writer knows of no equipment that will accurately and automatically control the moisture over long periods of time. An apparatus intended to serve this purpose is now in process of construction. A room located in the basement of the Agricultural Hall has been insulated and in this the apparatus will be operated. It will

answer only for medium and high temperatures. The object of this project is to discover some definite laws that govern the seasonal occurrence of insects. Our knowledge of the fundamental laws of economic Entomology is very limited, and while in some cases we seem to be able to explain certain phenomena through parasitism or through the agency of predaceous insects, yet these natural enemies are subject to the same laws as the host, and we are, therefore, required to go deeper than we have attempted to heretofore. The writer is fully aware that the subject is a most complex one, but with our present facility we feel warranted in undertaking it.

Project 16.

A Biological Study of the Slender Wire Worm, *Horistonotus Curiatus,* was continued during the year in cooperation with the section of Southern Field crop insects of the Bureau of Entomology and the Division of Chemistry and entomology of this Station. Mr. W. A. Thomas of this Division, was in charge of the Entomological and Cultural phases of the problem while Prof. T. E. Keitt directed the work on the commercial fertilizers and lime and stable manure. A current report of progress was issued in bulletin 155 of this Station. So far this insect seems to confine its work to the Coast and near-coast Counties, occurring in most destructive numbers over about 16 square miles in Colleton County. Though this species has been described many years ago this is the first report of injury in American Agriculture that we are aware of. As there are a number of species in Southern Agriculture that spend the greater portion of their lives underground, and as these other species could be observed incidentally in connection with the work on this Wire worm the problem was planned and presented for approval as an Adams project. Since the approval of this project the work has been enlarged by the establishment of an insect field laboratory at Sniders, and in the heart of the wire worm territory, with Mr. J. A. Dew in charge. The object of the problem is fully outlined in the original project.

Co-Operative Experimental Field Work.

This work was prosecuted with Hatch funds supplemented

by appropriations from State funds. The work was continued along the following lines:

Field Crop Insects.

The cotton and corn root louse, *Aphis-Maidi-radicis,* together with several undetermined species is conducted from the Marion insect laboratory cooperatively with "the section of field crop insects" of the United States Bureau of Entomology. A record of progress is now in preparation and will be issued as a Station bulletin as soon as the manuscript is completed. This insect is most seriously destructive mainly in the Pee Dee section. Although occurring in the Piedmont section and the costal sands it does comparatively little damage. Mr. Thomas ,in charge of this problem, incidentally made observations along other lines.

During the past year a study was made of the life history of the Southern corn root worm, observations having been carried on in several sections of the state. The life history work suggests a safety date for planting corn to avoid serious injury from this pest. These records are at present being compiled and will be issued as a Station bulltin this fall. The plan there proposed will be carrid out on a large scale in several sections of the State during the next season.

The Black Corn Bill bug, *Sphenophorus maidis,* is a most injurious corn pest principally in Marion, Dillon, Marlboro, and Chesterfield Counties. In appearance this species is very unlike the bill-bug occurring in the Southern part of the State, which is *Sphenophorus callosus.* The identification of this species was made through the courtesy of Dr. Howard, Chief of the Bureau of Entomology, by Dr. Chittenden. The life history was carefully studied by Mr. Thomas in the field and these records are at present being prepared to be issued as a Station bulletin in a short time.

Shade Tree Insects.

Attention of the Division was frequently called to two notorious shade tree pests infesting principally the Maple trees of the State. These insects are the Cottony maple scale, *Pulvinaria innumerabilis,* and the Gloomy scale, *Chrysom-*

iphalus tenebricosus. Experimental spraying work was carried on against these pests in several sections of the State Summer sprays of caustic potash whale oil soap at the rate of 1 to 4 were applied and were beneficial against the Cottony maple scale. Winter sprays were given as follows: Lime sulphur wash in December, intended to control the Gloomy scale, while an application of Kerosene mulsion varying from 15 to 25 per cent was applied in the spring with a view of controlling the Cottony maple scale. While the Lime sulphur wash controlled the Gloomy scale satisfactorily it had no effect on the cottony maple scale, and the kerosene emulsions applied had no appreciable effect. The work on the cottony maple scale will therefore be continued throughout this winter for the purpose of discovering the most effective remedy for this section.

Orchard Sprays.

This work was prosecuted cooperatively between the Divisions of Entomology and Plant Pathology. The cooperative experiments were located in different localities throughout the Piedmont section and as far South as the latitude of Columbia. Eight spray pumps of the Entomological Division were utilized in prosecuting this work and this enabled us to make a comparative test of the various types of barrel sprayers as to their efficiency, as well as their adaptability to our terraced and level orchards of the State. The object of this Division in carrying out this work was to test the efficiency of the various commercial Lime sulphur washes as winter sprays, as well as the various brands of arsenate of lead as summer sprays. Experiments were conducted as to the amount and time of spraying together with amount of spray material necessary and the cost of operation. The work was preceded by pruning operations in the various orchards as well as such measures as were necessary—to bring these orchards in good condition, as the orchards selected were intended to be used consecutive years until definite conclusions can be reached. Owing to the abnormaly dry season of 1911, it appears best not to judge the records of this season, but to continue the ex-

periments during next season with a view of making a full report of the work.

Miscellaneous Investigations.

Besides the regular problems undertaken by this Division, miscellaneous investigations are carried on incidentally. The important insect attacking the fig in this State is the Purple scale, *Lepidosaphes beckii*. It completely covers the bark of the trees causing them to die. Little advantage has been gained in the past by the application of winter sprays as it appears impossible to get a spray sufficiently penetrating to do the insect any serious damage. Owing probably to the very dry season of 1911 the hatching was most irregular and no satisfactory results were obtained. Preparations are made, therefore, for the purpose of carrying out fumigation tests this winter in one or two of the orchards for the purpose of determining whether this insect can be reached during the dormant season with Hydrocyanic acid gas.

An interesting experiment was made on the premises of Mr. F. G. Feaster, Buckhead, S. C., for controlling Craw Fish in a spring. These crustaceans had directed their channels through the floor of the spring and drained the water away. The spring furnished water supply by means of a hydraulic ram to a mill as well as to the premises. A gallon of Phinotas Oil, manufactured by the Phinotas Chemical Co., New York, was shipped to Mr. Feaster who had it very intelligently applied according to directions and reported on June 1st, as follows: "It gives me pleasure to report that the application of the oil you sent me last fall has been successful. My man reports the presence of many dead craw-fish, and the present flow is much greater than during a less severe drouth last summer. The man also says he thinks the water might have been used about two weeks after the application of the oil. This is a great astisfaction as the craw-fish had threatened to make useless the ram and pipe installed at considerable expense."

One of the features of the work of his Division during the past year is the establishment of the Field laboratories; one at Marion, the other at Sniders. These laboratories enable

us, first—to render quicker and more efficient service to the people in the sections in which these laboratories are located. Second—they enable the Entomologist in charge to specialize more closely on conditions and to study the insects in their native habitats, where heretofore the specimens had to be transferred to the laboratories at Clemson. This was unsatisfactory and inconvenient besides giving us results that were made ambiguous owing to the abnormal conditions in which the insects are compelled to develop. The work so far carried on at the Marion insect field laboratory makes it apparent that the best results in economic Entomology are secured not by artificial insectary methods, but by studying the pests in the fields where outbreaks occur. The Marion laboratory has already proved the wisdom of this departure, and both of these laboratories are rapidly growing in efficiency.

We are fortunate in having these laboratories in charge of men who, by their work and application here at Clemson, have proven themselves, and the writer is convinced that they will enable us to render much more efficient service to the people than we have been able to render before, funds being the same. Where it was necessary heretofore to travel across the State of South Carolina to investigate outbreaks in the Southern and Eastern sections of the State these gentlemen are always at hand and investigations can be made quickly and at much less expense. We are enabled to convert technical results into practical recommendations much quicker than we were able to do by operating directly from here.

The writer wishes to express his appreciation for your kindly interest and support in this work.

Respectfully submitted,

A. F. CONRADI,
Entomologist.

REPORT OF CHEMIST.

Clemson College, S. C., Nov. 11, 1911.

Prof. J. N. Harper, Director, S. C. Agricultural Experiment Station.

Dear Sir: I respectfully submit the following report of the

Chemical Division of the Station for the year ending June 30, 1911.

We have made satisfactory progress in our investigation work under the Adams Fund. Most attention has been given to the problems relative to the toxicity of cottonseed meal. Considerable time has been devoted to "A Study of the Cause of the Seeming Partial Insolubility of Potash Salts when Mixed with Basic Slag." The object of this investigation is to determine whether it is a fault of our present methods of analysis or a chemical reaction that takes place on mixing. The writer made this discovery when analyzing a number of home mixtures that had been prepared under his supervision.

The Sweet Potato Investigation has been completed, for the present, and the data is now being prepared to be published in bulletin form. No attempt will be made to breed for high starch content until the industry assumes some proportions. If the industry ever warrants this, we expect to take up hill to row breeding for high starch content. This can be carried out by determining the starch content of the hills and carrying over the vines from the most productive and highest starch yielding hills in the green-house. The objections to other methods are that the seed are rarely ever obtained and that there is no absolute certainty about preserving the roots.

The Chemist has planned and has charge of some field work, both at Clemson and at the Coast Station, on the availabilities of the sources of ammonia. This work is the outgrowth of the work on the "Relative Availabilities of Certain Animal Sources of Nitrogen." It is our intention to enlarge the scope of this work during the coming year. The Director has assured us of his hearty co-operation in this matter.

Some attention has been given to a study of the methods for determining phosphoric acid in basic slag. The use of this material, as a source of phosphorus, has assumed rather large proportions in this State and some accurate information both as to the availability of the phosphorus and the lime contained is highly necessary. We are carrying this work on both in the field and in the laboratory.

Publication.

This division has issued two bulletins this year: "The Formation of Sugars and Starch in the Sweet Potato" and "A Chemical Study of Certain Sandhill Soils of South Carolina." In addition we have issuel several press bulletins on subjects of interest to the farmers.

Farmers' Institute Work.

During the past year, the Chemist has enjoyed unusual opportunities to study the agriculture of the State in various sections, having been out on Farmers' Institute work for about seven weeks. The counties visited were: Colleton, Charleston, Bamberg, Georgetown, Williamsburg, Clarendon, Dorchester, Orangeburg, Calhoun, Richland, Laurens, Cherokee, York, Union, and Greenville.

Co-Operative Work.

The Chemist, in connection with the Entomologist, is engaged in co-operative work in Colleton County.

Co-Operative Work With Association of Official Agri-Cultural Chemists.

The Chemist co-operated with the referee on insecticides in trying out methods for analyses of insecticides.

Respectfully submitted,

T. E. KEITT,
Chemist.

REPORT OF ANIMAL HUSBANDMAN.

Clemson College, S. C., Dec. 1, 1911.

Prof. J. N. Harper, Director, S. C., Experiment Station.

Dear Sir: I respectfully submit herewith report of the Division of Animal Husbandry and Dairying for the year ending June 30th, 1911.

The study of the effects of cotton seed meal on dairy cat-

tle and hogs is being continued as previously outlined. The results obtained so far would not justify any definite conclusions. The cows fed exclusively on cotton seed meal for the grain ration for the past year, have all calved and been bred again, and are apparently in a healthy, normal condition.

One of the most important lines of work carried on by this division is the feeding of beef cattle. This branch of agriculture has already become a very important one. Last year about 7,000 head of cattle were imported and fattened on 185 farms in the State, and the object of our experiments is to assist in developing this industry. For this purpose three car loads of beef cattle were purchased and are being fed on different rations with the view of determining the most economical methods of fattening cattle on the feeds available in the State. At the close of the experiments, farmers of the State who are interested in this line of work, will be invited to visit the Station and see for themselves the results of the different systems of feeding. The results will also be reported in detail. The fertilizer obtained will be used in crop experiments. The records of the yield per acre will be kept in order to learn, if possible, the amount of money cattle feeders may be able to lose on account of unfavorable markets and still find it profitable to feed.

As dairying and hog raising have proved to be the most profitable lines of animal husbandry for the average farmer in the State, extensive experiments are being carried on with the view of developing this branch of farming and to determine the amount of milk and pork per acre that can be obtained from the crops easily grown in the State and also the amount of milk and pork per acre per year from the different crop rotations. These studies also involve the all-important factor of soil fertility and lessening the cost of producing the staple crops and animal products.

The new dairy building and dairy barn and hog pens recently completed provide excellent facilities for carrying on the work. One of the greatest needs at present is good fences and better pastures. I would also recommend the establish-

ment of a well equipped poultry plant with a competent man in charge as a branch of this division.

Respectfully,

A. SMITH,
Animal Husbandman.

REPORT OF SECRETARY AND LIBRARIAN.

Clemson College, S. C., Dec. 1, 1911.

Prof. J. N. Harper, Director, S. C. Experiment Station.

Dear Sir: I herewith submit a report of some of the work that has been done in the office of the Secretary of the South Carolina Experiment Station during the fiscal year just closed, June 30th, 1911. The amount of work has been multiplied many times within the past decade.

The appreciation in which the Experiment Station bulletins, is held becomes more manifest with each succeeding year. This office has become a repository of much valuable information, which is not so readily accessible elsewhere in its present shape, as is shown by the ever increasing demand for our publications, not only within our own borders, but outside,—from the Atlantic to the Pacific and from the Lakes to the Gulf. The rapid development of a sentiment favorable to the extension of agricultural features of instruction in all rural communities, has also largely increased the demand for the bulletins of this office.

During the past fiscal year this Station has issued six bulletins and one annual report. These contain in the aggregate 207 pages. The bulletins were distributed in an edition of 102,000 copies. They represent scientific discussions on the questions of "Corn and Cotton Wire Worm," "Permanent Lawns for the South," "A Chemist Study of Certain Sandhill Soils of South Carolina," "The Apple Tree Tent Caterpillar," "The Formation of Sugars and Starch in the Sweet Potato," and the "Analysis of Commercial Fertilizers."

In addition to the above, a leaflet of four pages containing the analyses of commercial fertilizers, was published at the

College and mailed from this office weekly for thirty consecutive weeks in editions of 16,000 each. This was a guarantee to the farmers of safety against the use of fraudulent fertilizers.

The number of bulletins, including fertilizer leaflets, press Bulletins, etc., amounted to 582,000 copies that were mailed from this office.

In the past year there was a material increase in the number of accessions to the mailing list. There were approximately 3,000 new names added.

The library of the Experiment Station receives the best attention available for the work at present, and as a result it is growing in influence, in special interest, and in general usefulness.

Very truly yours,

JN

Secretary

. N. HOOK,

nd Librarian.

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of

TWENTY-FOURTH ANNUAL REPORT

OF THE

South Carolina Experiment Station

OF THE

Clemson Agricultural College

FOR THE YEAR ENDING

JUNE 30, 1911

Anderson, S. C.
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